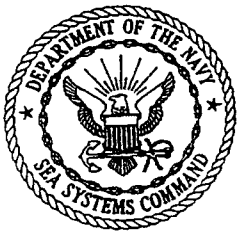
S6220-EU-MMA-010

TECHNICAL MANUAL
FOR

COMPRESSOR, AIR, LOW PRESSURE, OIL-FREE, MODEL STAR 200C and 200D

with

RIX PROGRAMMABLE LOGIC CONTROLLER (PLC)



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FOREWARD

This technical manual provides information necessary to operate, maintain, and repair (at organizational, intermediate, and depot levels) the rotary, single screw, water flooded, low-pressure air compressor, Model STAR 200 C and D. The contents of this document were prepared in accordance with Technical Manual Contract Requirement (TMCR) No. NDMS 880420-000 and subordinate TMCR 880420-004. In accordance with the TMCR, the information in this technical manual is divided into eight chapters, as follows:

Chapter 1.	General Information and Safety Precautions
Chapter 2.	Operation
Chapter 3.	Functional Description
Chapter 4.	Scheduled Maintenance
Chapter 5.	Troubleshooting CMS and Electrical Components
Chapter 6.	Corrective Maintenance
Chapter 7.	Parts List
Chapter 8.	Installation

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SAFETY SUMMARY

GENERAL SAFETY NOTICES

The following general safety notices supplement the specific warnings and cautions appearing elsewhere in this manual. They are recommended precautions that must be understood and applied during operation and maintenance of the equipment covered herein. Should situations arise that are not covered in the general or specific safety precautions, the commanding officer or other authority will issue orders as deemed necessary to cover the situation.

DO NOT REPAIR OR ADJUST ALONE

Under no circumstances shall repair or adjustment of energized equipment be attempted alone. The immediate presence of someone capable of rendering aid is required. Before making adjustments, be sure to protect against grounding. If possible, adjustments should be made with one hand, with the other hand free and clear of equipment.

TEST EQUIPMENT

Make certain test equipment is in good condition. If a test meter must be held, ground the case of the meter before starting measurement. Do not touch live equipment while holding a test meter. Some types of measuring devices should not be grounded; these devices should not be held when taking measurements.

MOVING EQUIPMENT

Personnel shall remain clear of moving equipment. Should equipment require adjustment while in motion, a safety watch shall be posted. The safety watch shall have a full view of operations being performed and immediate access to controls capable of stopping equipment motion. If at any time the compressor appears to be moving out of control, equipment should be shut down immediately.

FIRST AID

An injury, no matter how slight, shall never go unattended. Always obtain first aid or medical attention immediately.

RESUSCITATION

Personnel working with or near high voltage shall be familiar with approved methods of resuscitation. Should someone be injured and stop breathing, resuscitation shall be initiated immediately. A delay could cost the victim his life. Resuscitation procedures shall be posted in all electrically hazardous areas.

GENERAL PRECAUTIONS

The following general precautions are to be observed at all times.

1) All electrical components associated with this system/equipment shall be installed and grounded in accordance with applicable Navy regulations and approved shipboard practices.

2) All maintenance operations shall comply with Navy Safety Precautions for Forces Afloat, OPNAVINST 5100 series.

3) Precautions set forth in Naval Ships' Technical Manual (NSTM), chapters 300, 302, 310, and 320, shall be observed with respect to electrical equipment and circuits.

4) Procedures and precautions of NSTM, chapters 505 and 556, shall be observed with respect to hydraulic system components and piping.

5) In breaking flange joints, ensure that two diametrically opposed securing nuts or bolts remain tight while the remainders are loose. The two remaining fasteners shall then be loosened sufficiently to permit breaking the joint to prove the line is de-pressurized. Lines should be drained prior to disassembly.

6) Proper installation and maintenance of protective guards and shutdown devices around rotating parts of machinery and high voltage sources shall also be observed.

7) Special precautionary measures are essential to prevent applying power to the system/equipment at any time maintenance work is in progress. All types of commander instructions regarding tag-out procedures must be followed.

8) Do not make any unauthorized alterations to equipment or components.

9) Before working on electrical system/equipment, ensure that system is not energized.

10) All circuits not known to be dead must considered live and dangerous at all times.

11) Do not wear loose clothing while working around rotating parts of machinery.

12) When working near electricity, do not use metal rules, flashlights, metallic pencils, or any other objects having exposed conducting material.

13) Be sure to de-energize all equipment before connecting or disconnecting meters or test leads.

14) When connecting a meter to terminals for measurement, use range higher than expected voltage.

15) Before operating equipment or performing any test or measurements, ensure that frames for all motors and starter panels are securely grounded.

16) Ensure that area is well ventilated when using cleaning solvent. Avoid prolonged breathing of fumes and solvent contact with skin or eyes.

ELECTROSTATIC DISCHARGE SENSITIVITY

Some of the STAR 200 Controller's electronic components have been determine to be Electrostatic Discharge Sensitive (ESDS). This means that they are extremely susceptible to damage from static charges, which can be generated by personnel, equipment, and packaging that come in contact or near ESDS components. Due to their susceptibility, these parts demand special usage requirements for protection from ESDS damage. Requirements include specific handling, transportation, and packaging of these items and associated hardware.

HANDLING OR REPAIRING ESDS ITEMS

The following procedures should be followed when handling or repairing ESDS items.

1) Perform all repairs of ESDS items on Electrostatic Discharge (ESD) protected workbenches.

2) Attach wrist ground strap (or equivalent) prior to handling ESDS items.

3) Use only soldering irons having grounded tips and ESD protective solder extractors for soldering operations.

4) Assure that all test equipment, electrical tools, and containers used on ESD protected areas are grounded before and during use.

5) Ground all leads of test equipment prior to energizing and before probing ESDS component terminals.

6) Upon completion of replacement of an ESDS assembly, repackage defective ESDS item in protective packaging material and assure proper marking. Place the ESDS assemblies in protective tote boxes or trays for transporting.

For more information on handling and packing of ESDS sensitive devices refer to the following Reference Publications.

DOD-STD-1686, Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices).

DOD-HDBK-263, Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices).

WARNINGS AND CAUTIONS

Specific warnings and cautions applying to the system/equipment covered by this manual are summarized below. These warnings and cautions appear elsewhere in the manual following paragraph headings and immediately preceding the text to which they apply. They are repeated here for emphasis.

WARNING

Identifies an operating or maintenance procedure, practice, condition, or statement that, if not strictly followed, could result in injury or death to personnel. (Page 1-1.)

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone. (Pages 5-6, 5-7, 5-12, 5-13, 5-14, 5-15, 5-16, 5-24, 5-25, 5-26, 5-39, 5-40, 6-64 an

Delete this WARNING from the listed pages and substitute with the WARNING found on page 6-14.

WARNING

Open the drain/pressure relief valve prior to opening the water filter assembly. This is necessary to relieve the pressure in the filter housing and prevent personal injury. (Page 6-44.)

WARNING

Compressed air is dangerous. Ensure relief valve air lines are drained to atmospheric pressure before disconnecting valve. (Page 6-6.)

WARNING

Pressure air is dangerous. Remain clear of relief valve discharge elbow. (Page 6-6.)

WARNING

Pressure air released by relief valve is dangerous. Ensure valve installed with discharge elbow directed downward. (Page 6-7.)

WARNING

To avoid harm to personnel, LPAC must not be started with relief valve loose or removed. (Page 6-10.)

WARNING

Compressed air is dangerous. Ensure air-end separator tank is at atmospheric pressure prior to starting removal of relief valve. (Page 6-10.)

WARNING

Pressure air is dangerous. Always vent all pressure before working on or disconnecting pressure piping. (Pages 6-14 and 6-59.)

WARNING

To avoid harm to personnel, LPAC must not be started with separator hoses loose or removed. (Pages 6-52 and 6-53.)

WARNING

To avoid harm to personnel, assure LPAC compressor assembly is at atmospheric pressure before disconnecting. (Page 6-13.)

WARNING

Sealant will irritate skin and eyes and is harmful if swallowed. Avoid contact with skin and prolonged breathing of vapors. (Page 6-14.)

WARNING

To avoid harm to personnel, LPAC must not be started with check valve loose or removed. (Pages 6-14 and 6-37.)

WARNING

Compressed air is dangerous. Always vent any residual air pressure before working on or disconnecting pressure piping. (Page 6-14.)

WARNING

To avoid harm to personnel, LPAC must not be energized while working on internal components. (Page 6-17.)

WARNING

Compressed air is dangerous. Always vent any residual air before starting disassembly of compressor. (Page 6-20.)

WARNING

To avoid harm to personnel, LPAC must not be started with separator hoses loose or removed. (Page 6-53.)

WARNING

Delete. This is a duplicate WARNING from the previous page.

WARNING

To prevent injury or death, ensure equipment is de-energized and tagged OUT-OF-SERVICE at the source. (Pages 6-26, 6-29, 6-46, 6-50, and 8-7.)

WARNING

To avoid serious injury, wear insula gloves when handling extremely col hot component. (Page 6-35.)

Delete. This is a duplicate WARNING from the previous page.

WARNING

To avoid harm to personnel, LPAC must not be started with relief valve loose or removed. (Page 6-10.)

WARNING

To avoid harm to personnel, LPAC must not be started with valve disconnected or removed. (Page 6-42 and 6-44.)

WARNING

Plate assemblies are sharp. Wear leather gloves and exercise care when handling plate assemblies. (Page 6-56.)

WARNING

To avoid harm to personnel, LPAC must not be started with pilot valve loose or removed. (Page 6-59.)

WARNING

To avoid harm to personnel, LPAC must not be started with valve connections loose or hoses removed. (Page 6-61.)

WARNING

The crated compressor weighs approximately 4000 pounds. Use only equipment rated for this weight for moving and installation of the unit. Serious injury may result to personnel if underrated equipment is used. (Page 8-4.)

WARNING

The uncrated compressor weighs approximately 3200 pounds. Use only equipment rated for this weight for moving the compressor. Serious injury may result to personnel if underrated equipment is (Page 8-5.)

WARNING

To prevent injury or death, ensure electrical circuit is de-energized at the source and tagged OUT-OF-SERVICE. (Page 8-7.)

CAUTION

Identifies an operating or maintenance procedure, practice, condition, or statement that, if not strictly followed, could result in equipment damage or serious impairment of system operation. (Page 1-1.)

CAUTION

Internal compressor assembly components are lubricated by injected potable water. Operating LPAC with either excess or low separator assembly water levels can damage compressor assembly components and cause premature failure of LPAC. (Pages 2-14, and 2-17.)

CAUTION

No safeties are active during Battle Override Operation. The PLC does not monitor or shutdown for any compressor failure. The water level must be manually controlled by an operator. (2-7 and 3-14.)

CAUTION

Always put controller in manual mode prior to turning OFF power, The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration. (Pages 2-7, 2-13, 2-16, 2-18, 5-6, 5-9, 5-12, 5-14, 5-15, 5-16, 5-17, 5-18, 5-19, 5-20, 6-6, 6-13, 6-17, 6-23, 6-25, 6-28, 6-29, 6-37, 6-40, 6-42, 6-44, 6-46, 6-50, 6-52, 6-53, 6-55, 6-59, 6-61, 6-63 and 6-64.)

CAUTION

If INJECTION WATER PRESSURE gauge (6, Figure 2-2) fails to read a minimum of 25 PSIG within 10 seconds of starting the LPAC in BATTLE OVERRIDE mode, stop the LPAC by setting the ON/OFF selector switch (5, Figure 2-1) to the OFF position. Continued operation with low injection water pressure can damage the LPAC. (Page 2-16.)

CAUTION

Contaminated air may cause damage to the LPAC compressor assembly internal components. Do not operate the LPAC without the air inlet filter connected and/or CBR filter connected and a filter element in place. (Page 3-8.)

CAUTION

Separator assembly can contain pressure in excess of ship's potable water system pressure. Do not open manual SEPARATOR FILL ball valve unless LPAC is stopped and separator assembly is at atmospheric pressure or well below ship's potable water system pressure. (Page 3-9.)

CAUTION

Operating LPAC with low injection water pressure can cause damage to internal air-end components. (Page 5-33.)

CAUTION

Pointer is assembled to shaft using Loctite. Prying-off will damage gauge works. (Page 6-3.)

CAUTION

To prevent contamination of piping and components with dirt and foreign matter, ensure that all openings are covered with pressure sensitive tape. (Page 6-7.)

CAUTION

To prevent damage to equipment, do not allow machined or lapped mating surfaces to contact any surface without protection against nicks, scratches, and burrs. (Page 6-9.)

CAUTION

To prevent damage, assure that check valve assembly does not fall to the deck when the last mounting nut is removed. (Page 6-14.)

CAUTION

To prevent damage to gate rotor machined surfaces, ensure that gate rotor assembly does not fall to deck when mounting nuts removed. (Page 6-20.)

CAUTION

Tilting and twisting should be done without force. When looking into gate rotor compartment it becomes apparent that thrust end of gate rotor assembly moves first to enable disengagement of gate tooth from main rotor flute. (Page 6-20.)

CAUTION

Installation of gate rotor assembly must be accomplished without force of any kind to assure that leading edges of gate rotor are not damaged. (Page 6-21.)

CAUTION

To avoid damage, only an experienced hoist operator should be allowed to move heavy components. (Pages 6-26, 6-29, and 6-53.)

CAUTION

Excessive lubrication may damage drive motor. Do not over grease. (Page 6-28.)

CAUTION

To prevent damage, do not drag rotor iron across stator iron. (Page 6-28.)

CAUTION

When replacing ball bearing on rotor shaft, apply pressure only to inner race of bearing. (Page 6-28.)

CAUTION

Do not damage or distort hanger spring between core and diaphragm subassembly. (Page 6-48.)

CAUTION

When removing tank level switch, be careful not to bend rod or chip floats. (Page 6-53.)

CAUTION

To avoid damage, only an experienced hoist operator should be allowed to move heavy components. Heat exchanger is very heavy. (Page 6-56.)

CAUTION

Never open heat exchanger when it is hot. The unit should be cooled to room temperature before opening to prevent loosening of gaskets. (Page 6-56.)

CAUTION

Do not use steel brush or wool to clean plates. If brush is required, a fiber type is recommended. If absolutely necessary to use steel brush, a stainless steel brush is recommended. Be careful not to scratch gasket surfaces. (Page 6-56.)

CAUTION

Do not apply excessive adhesive. Adhesive should not ooze out when gasket is pressed into groove. (Page 6-59.)

CAUTION

Care must be used when transporting and handling the crated compressor to prevent damage to its contents. Before uncrating move the compressor as near as possible to the installation location. (Page 8-4.)

CAUTION

The piping and flanges must be cleaned of all welding flux and other foreign matter prior to attaching it to the LPAC. Damage to heat exchanger plates and gaskets, and internal LPAC parts will result if solid matter is allowed to enter unit. (Page 8-5.)

CHAPTER 1
GENERAL INFORMATION AND SAFETY PRECAUTIONS

1-1. SAFETY PRECAUTIONS.

Warnings and cautions appearing throughout this technical manual are important to personnel and equipment safety. Before attempting to operate, maintain, troubleshoot, or repair any part of the model STAR 200 low-pressure air compressor (LPAC), all warnings and cautions should be thoroughly reviewed and understood. Refer to the safety summary that appears in the front matter of this manual. The following paragraphs define warnings, cautions, and notes as they are used in this manual.

WARNING

Identifies an operating or maintenance procedure, practice, condition, or statement that, if not strictly followed, could result in death or injury to personnel.

CAUTION

Identifies an operating or maintenance procedure, practice, condition, or statement that, if not strictly followed, could result in equipment damage or serious impairment of system operation.

NOTE

Highlights certain operating or maintenance conditions or statements that are essential but not of known hazardous nature.

1-2. INTRODUCTION.

1-2.1 Purpose. This manual provides information for the operation, maintenance, and installation of the rotary, single screw, water-flooded, model STAR 200 LPAC (Figure 1-1).

1-2.2 Scope. This manual contains a detailed description of the LPAC. In addition, sufficient information is presented to enable personnel to install, operate, maintain, troubleshoot, or repair the LPAC. The illustrated parts breakdown (IPB) in chapter 7 contains listings and cross-referencing of all components. This manual covers all levels of maintenance (organizational, intermediate, and depot).

1-2.3 Supersedure Data. This manual is for a new LPAC design and does not supersede any other current manual.

Ad in this m 200 LPAC.

Global comment through-out manual. Per TMCR requirements, the first letter of each word of an acronym shall be capitalized.

1-3. EQUIPMENT DESCRIPTION.

1-3.1 General. The STAR 200 LPAC is used to supply shipboard low-pressure air. It is a rotary, single-screw, water-flooded compressor. It delivers 200 standard cubic feet per minute (SCFM) of oil-free compressed air at 125 pound-force per square inch gage (PSIG). It is powered by a 60 horsepower (hp), 3-phase, 60 hertz (Hz), 440 volt alternating current (vac) motor. LPAC operation is monitored and controlled automatically by a compressor management system (CMS) containing the programmable logic controller (PLC). The STAR 200 LPAC is designed for continuous duty.

1-3.2 Functional Design. (Refer to Figure 1-2.) During operation, ambient air is drawn into the LPAC through the air inlet filter and the ship's chemical, biological, and radiological (CBR) filter or through the ship's CBR filter flange connection. The intake air is mixed with injected potable (fresh) water in the compressor assembly. Compression of the air/water mixture takes place in a single stage through the interaction of a rotating screw-like main rotor and its two mating gate rotors. The compressed air/water mixture is piped to the separator assembly, which removes and stores the water for reuse. The compressed oil-free air is discharged to the ship's low-pressure (LP) air system. The stored potable water is piped through the heat exchanger and water filter assemblies for conditioning prior to re-injection into the compressor assembly. Lubrication of compressor assembly internal parts is achieved by the unique water-flooding design. The use of water for a lubricant ensures oil-free air. The injected potable water also cools the compressed air and seals the compression cavities between the main and gate rotors.

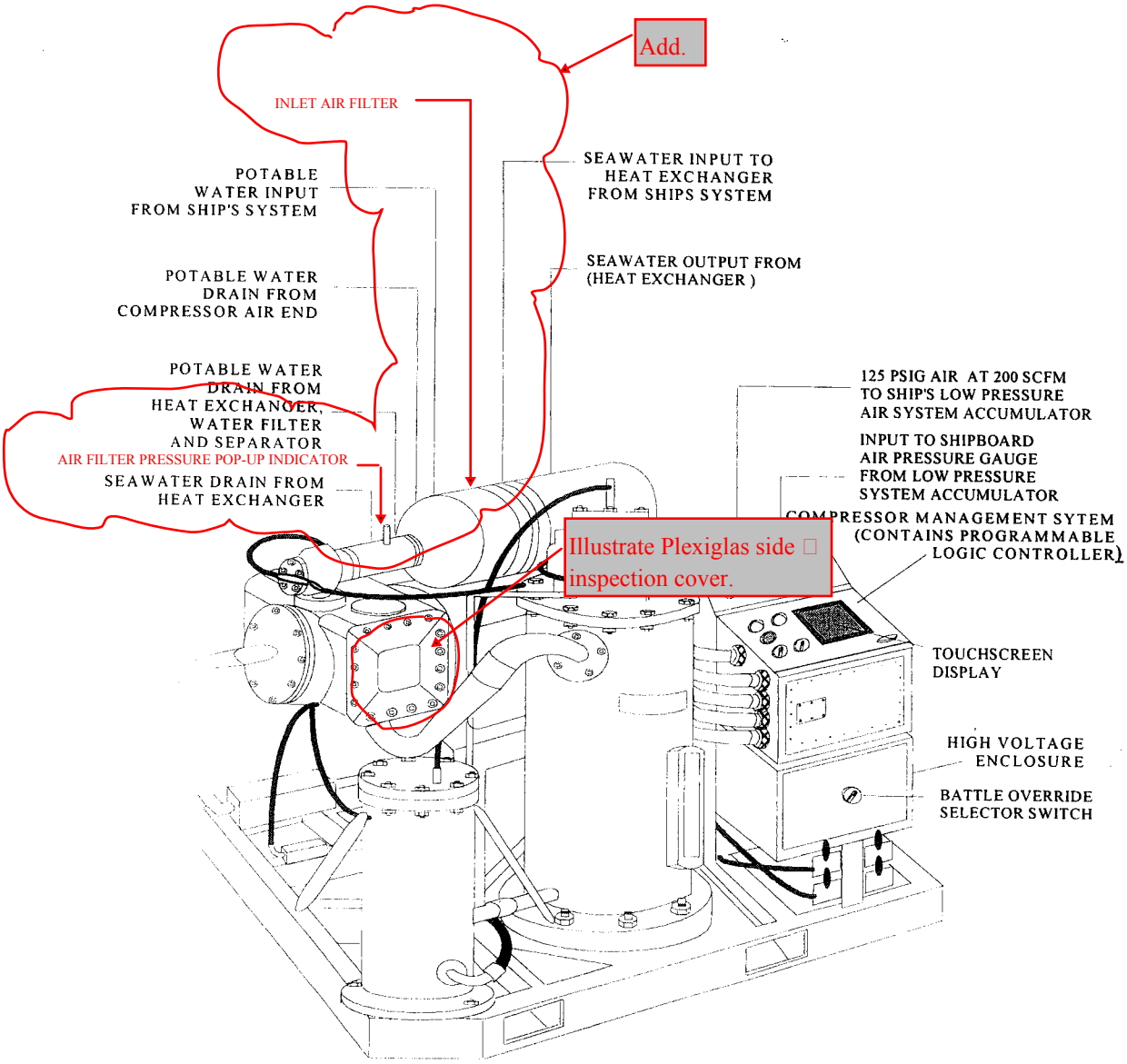

Figure 1-1. Model STAR 200 LPAC

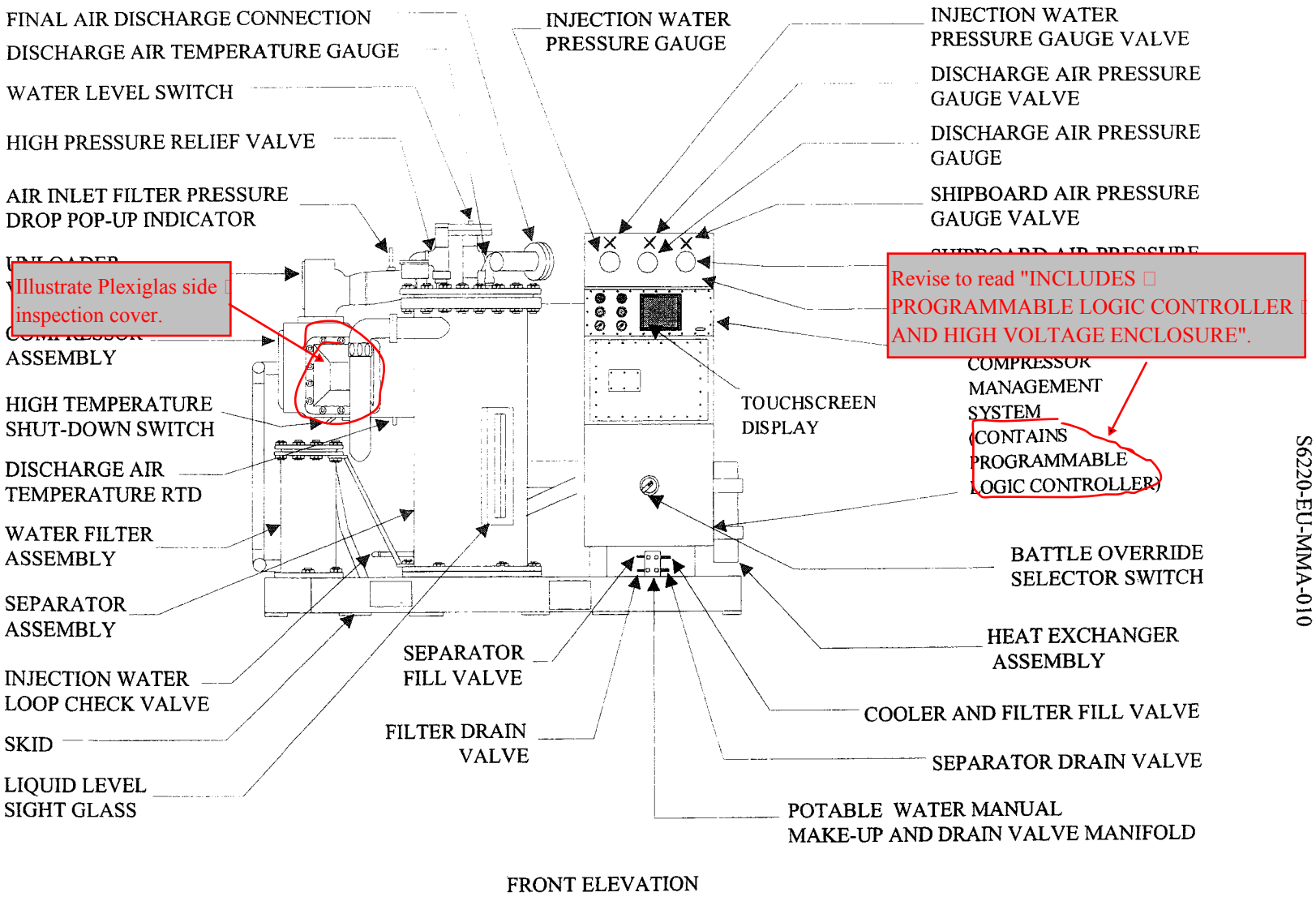

Figure 1-2. Model Star 200 LPAC Configuration (sheet 1 of 5).

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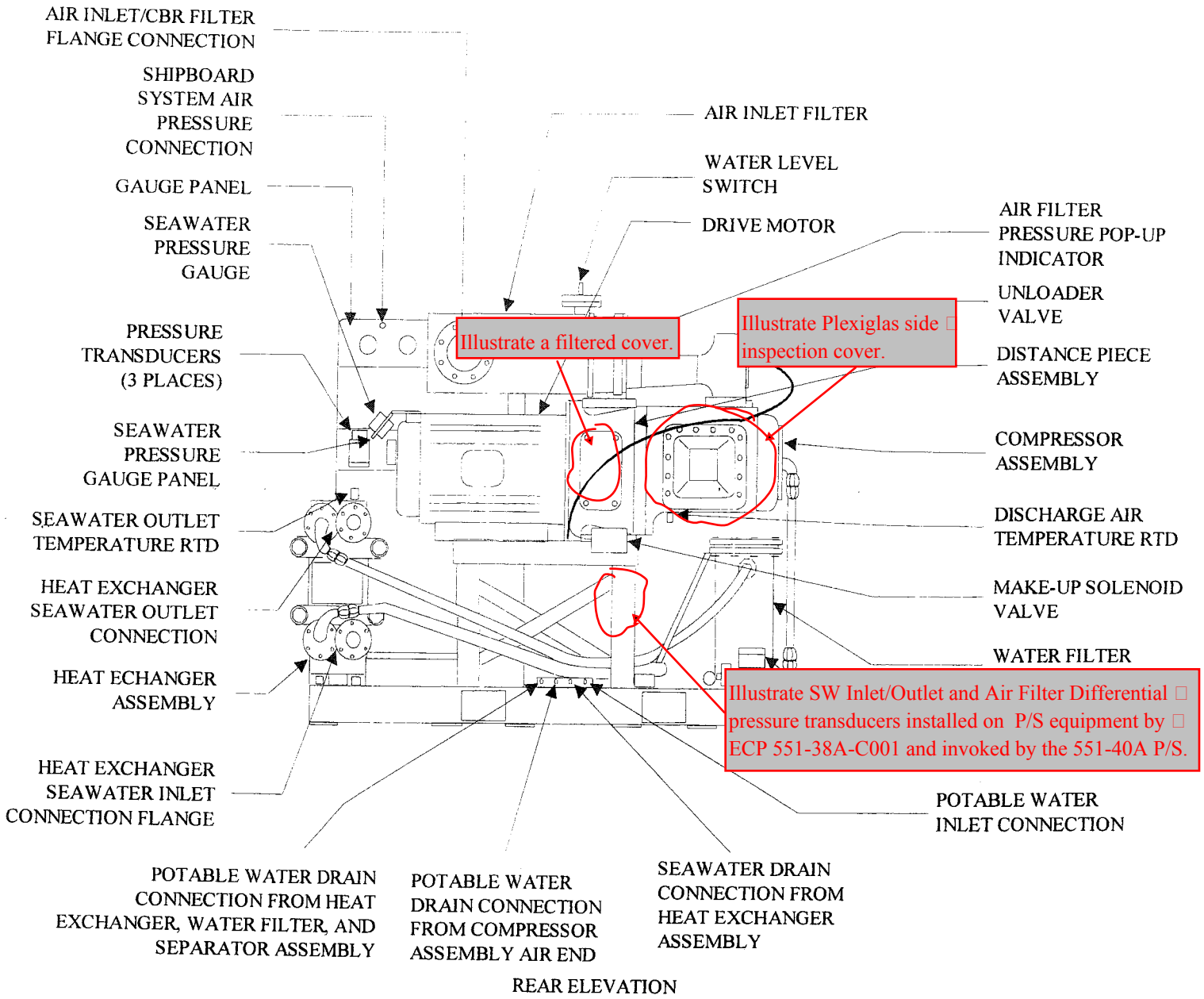

Figure 1-2. Model STAR 200 LPAC Configuration (sheet 2 of 5).

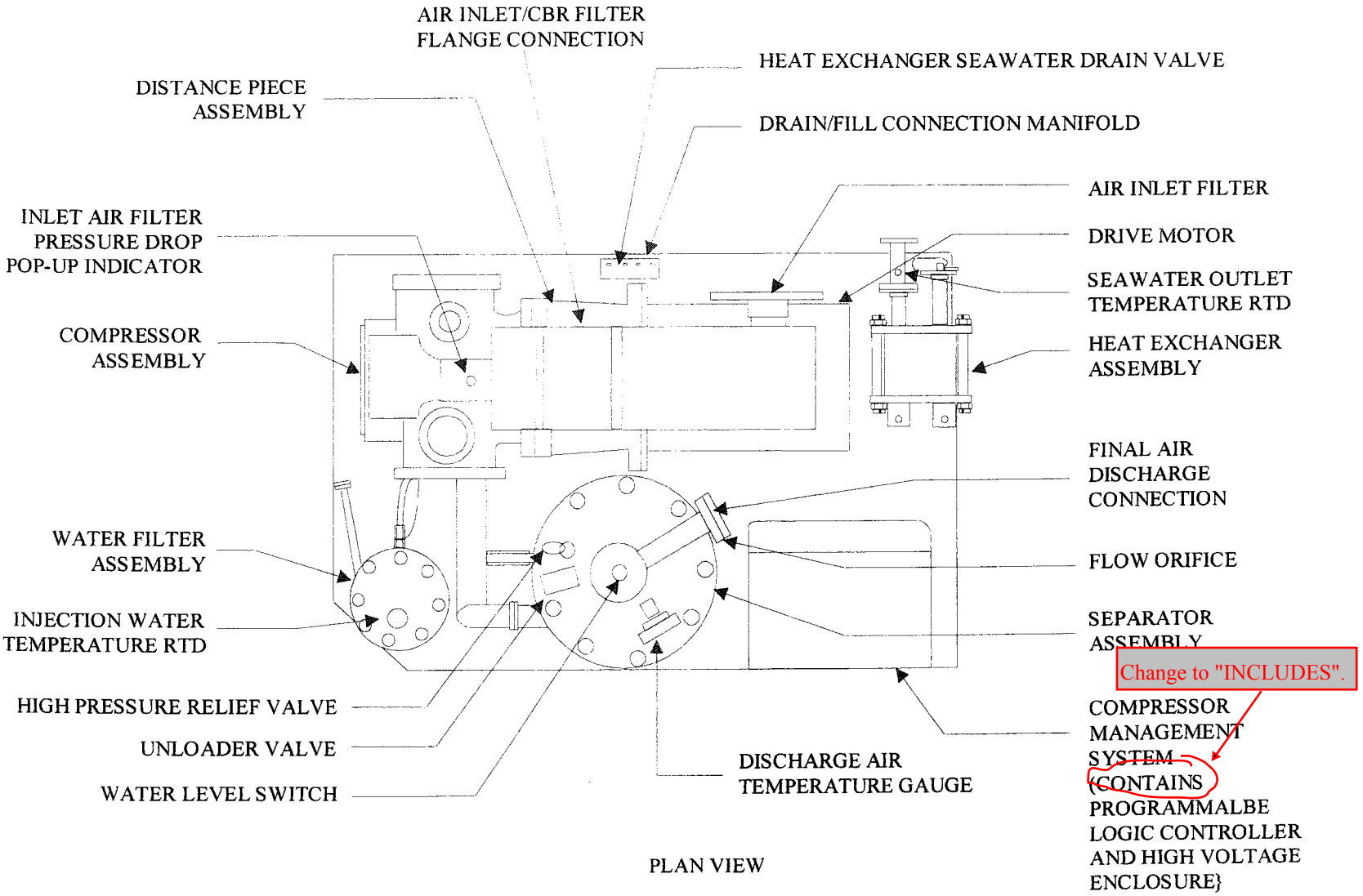

Figure 1-2. Model STAR 200 LPAC Configuration (sheet 3 of 5).

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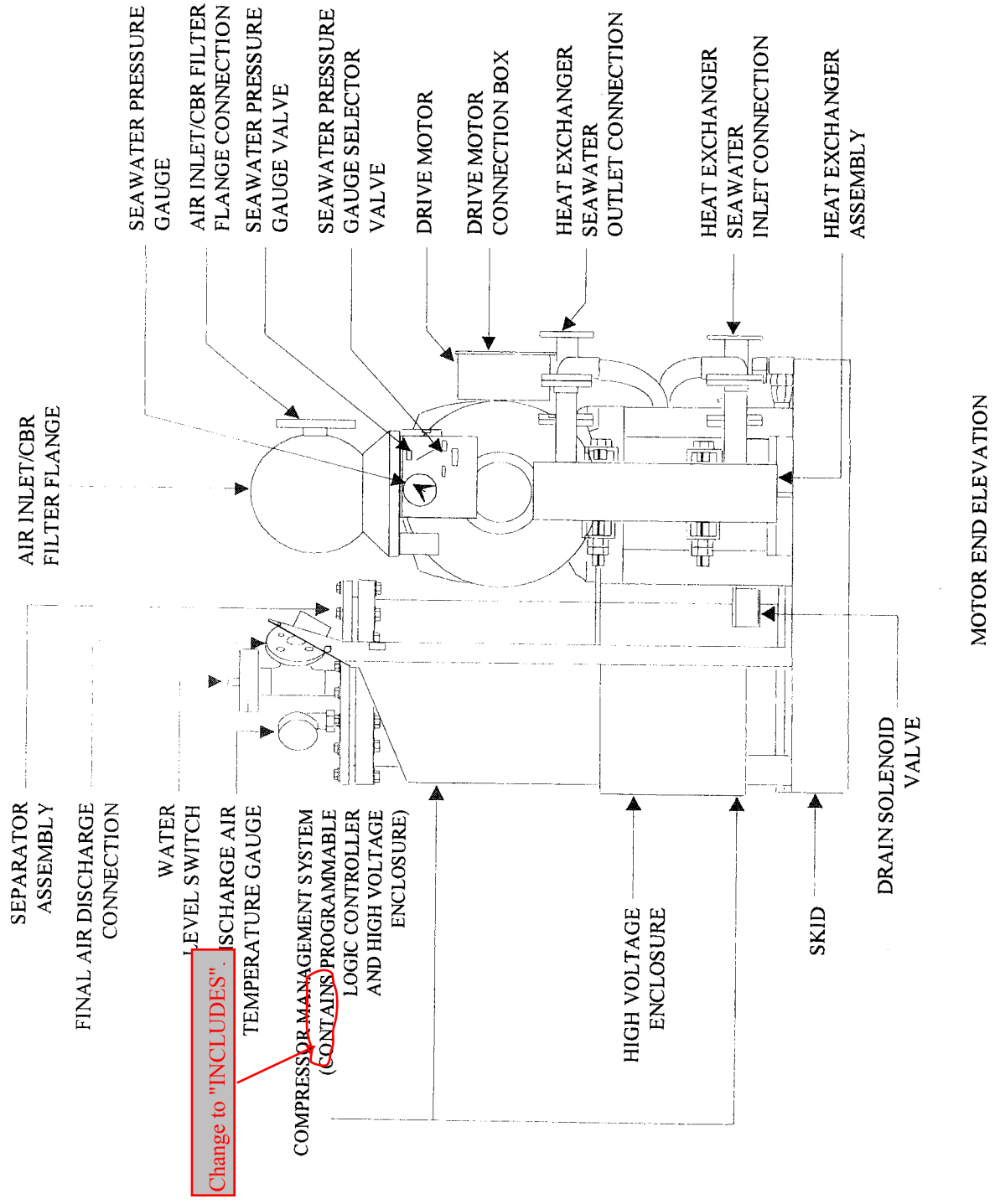
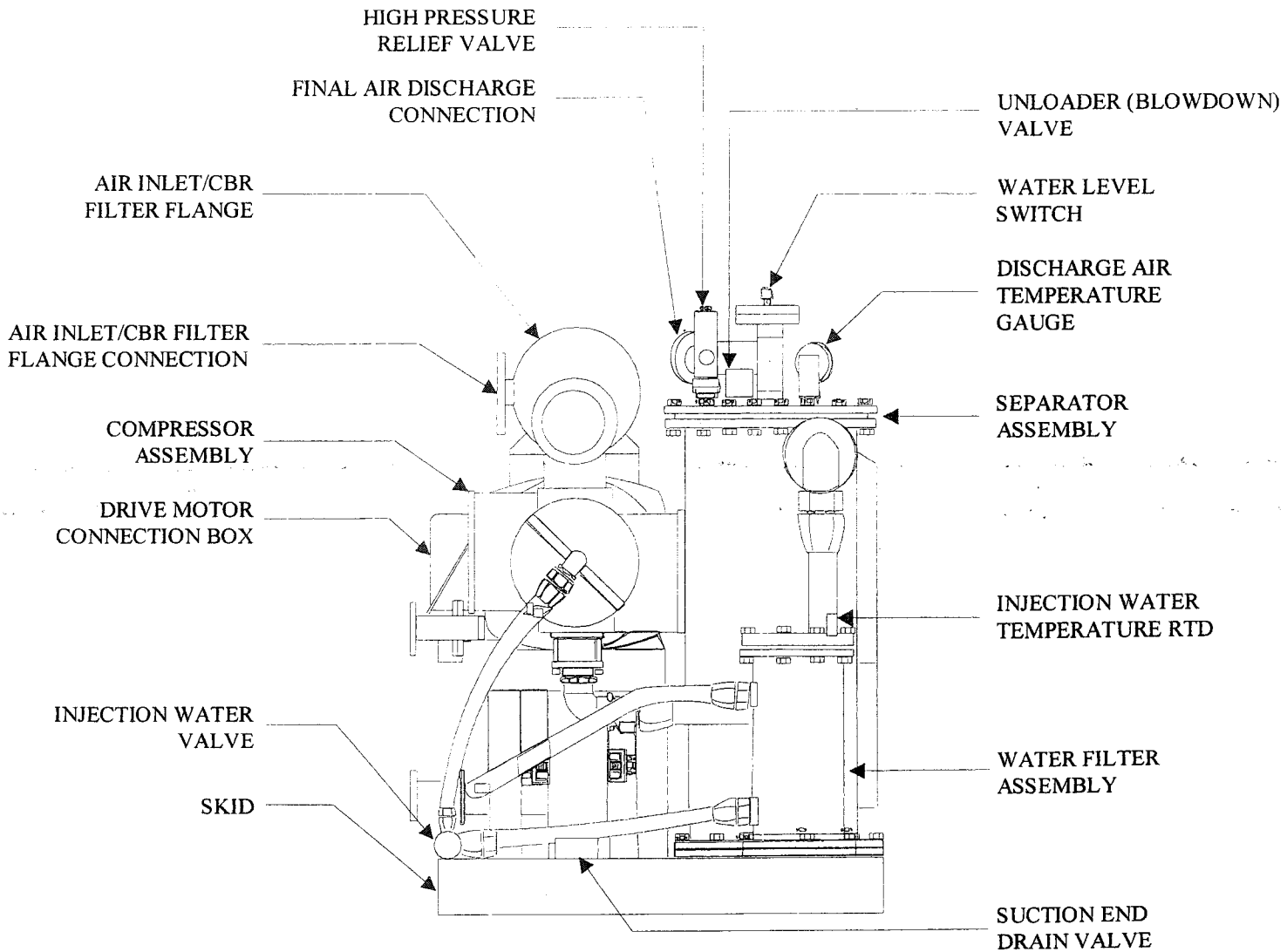


Figure 1-2. Model STAR 200 LPAC Configuration (sheet 4 of 5).



COMPRESSOR AIR END ELEVATION

Figure 1-2. Model STAR 200 LPAC Configuration (sheet 5 of 5).

1-3.2.1 Automatic Control of LPAC. The LPAC is controlled and protected by the CMS. The PLC controller, contained within the CMS, allows either manual or automatic operation of the LPAC. In the automatic-mode, the PLC controller starts the LPAC on demand by the ship's LP air system. When the default upper-pressure limit is detected the PLC controller causes the LPAC to start reduced (unloaded) operation. If a demand is detected during unloaded operation the PLC controller automatically returns the LPAC to full pressure operation. If no system demand is detected after 10 minutes of unloaded operation the PLC controller automatically stops the LPAC. During automatic mode operation the PLC controller opens and closes solenoid valves to maintain the potable water level in the separator assembly within defined limits. Additionally, during automatic mode operation, the PLC controller monitors LPAC operation, displays operational data for the operator and will automatically shutdown the LPAC if a default fatal limit is detected. Table 1-3 lists the preset default limits. A default limit can be reprogrammed using the PLC touchscreen display (Figure 1-2).

1-3.2.2 Manual Control of LPAC. In the manual-mode the LPAC must be started manually each time air is required. The PLC monitors LPAC operation and will automatically stop the compressor when system pressure reaches the default upper-pressure limit or a default fatal limit is detected. The PLC maintains the water level in the separator assembly automatically and displays operational data for the operator.

1-3.3 Configuration. (Refer to Figure 1-2.) The STAR 200 LPAC is a self-contained unit. The compressor assembly, drive motor, heat exchanger assembly, CMS, r filter id.

Global comment. Delete the word "controller" when used after the acronym PLC.. Re: Controller is redundant to the letter "C" in the acronym PLC.

s of the STAR 200 LPAC.

1-5. EQUIPMENT, ACCESSORIES, AND DOCUMENTS SUPPLIED.

Table 1-2 lists the equipment, accessories, and documents supplied with the STAR 200 LPAC.

Table 1-1. STAR 200 LPAC Characteristics

Nomenclature	Characteristic
Manufacturer	RIX Industries
Type	rotary, single-screw, water-flooded
Model	STAR 200
Part Number	C-STAR-200C/C-STAR-200D
Capacity at 125 PSIG	200 scfm
Discharge Pressure	125 psig
Discharge Air Temperature	122 degrees Fahrenheit (deg F) (maximum)
Intake Air Temperature Range	40 - 122 deg F (maximum)
Intake Air Pressure	12.7 to 18.7 pound-force per square inch absolute (psia)
Relative Humidity	0 - 50 percent
Drive Motor:	
Type	squirrel cage induction
Rotation	counterclockwise (as viewed from shaft end)
Rating	60 hp
Frame Type	326TNY
Voltage	440 vac.
Phase	3
Frequency	60 Hz
Current (Fully Loaded)	71.5 amperes (amps)
Speed (Fully Loaded)	3,565 revolutions per minute (rpm)

Table 1-1. STAR 200 LPAC Characteristics (continued)

Nomenclature	Characteristic
(Drive Motor – continued)	
Temperature Ambient	50 degrees Celsius (deg C) (maximum)
Insulation Class	B
Enclosure	drip proof
Mounting	horizontal
Lubrication	injected potable (fresh) water
Injected Water Pressure	25 - 105 pound-force per square inch (psi)
Seawater Pressure	20 - 175 psi
Cooling	seawater/potable (fresh) water loop
Heat Exchanger:	
Type	Plate and frame
Manufacturer	Tranter, Inc. - Texas Division
Model	UX-056-UJ-31
Mfg. Part Number	UX-056-UJ-031
Unit Flow Rate	40 gallons per minute (gpm)
Plates (Number/Material)	31/titanium
Inlet Temp. (Fresh/Seawater) max.	112.2 deg F / 95.0 deg F
Outlet Temp. (Fresh/Seawater)	105.0 deg F / 102.4 deg F
Press. Drop (Fresh/Seawater)	1.95 psi/2.06 psi
Heat Exchanged	145,210.9 British Thermal Units (BTU's) per hour (hr)
Design Pressure	175 psig
Text Pressure	263 psig
Desi	
Unit	
Unit	2" wide (w) X 17.75" deep (d)
Noz	
Seawater flow Rate	40 gpm
Seawater Temperature	95 deg F (maximum)
High Pressure Relief Valve Setting (Separator or Air End)	150 psig
Air Intake Filter	10 microns
Injection Potable (Fresh) Water Filter	20 microns
Gauges:	
Injection Water Pressure	0 - 200 psig
Discharge Air Pressure	0 - 200 psig
Ship's System Air Pressure	0 - 200 psig
Compressor Management System:	
Type	Microprocessor, programmable logic chip-set
Power Requirement	115 VAC, single phase, 60 Hz
Dimensions	36" h X 21" w X 8" d
Weight	190 lbs
Operating Temperature	0 deg C to + 50 deg C
Non-Operating Temperature	-12 deg C to +71 deg C
Operating Humidity	95% maximum
Heat Dissipation	1,707 BTU/hr

Revise the Nomenclature and Characteristics columns to distinguish relief valve settings of 175 PSI for the air end and 150 PSI for the separator.

Table 1-2. Equipment, Accessories, and Documents Supplied

Qty.	Item Name	Overall Dimensions	Weight (Lbs.) Crated	Uncrated	Volume (Cu. In.) Crated
1EA	Air Compressor, Rotary, Electric Motor Driven, Single-Screw, Water-Flooded, 200 scfm, Model STAR 200	64.0" Long X 41.5" Wide X 58.5" High	3,350	3,120	280,000
2EA	Star 200 Addendum Technical Manual	8.5" Wide X 11.0" High			

Delete.

Table 1-3. Factory Preset Default Values

DEFAULT MESSAGE	PURPOSE	PRESET VALUE
INJ PRE-START FATAL LOW = XXXX PSI	Selectable from 0 to 9999 psi. Determines minimum injection water pressure required for LPAC to start. Any pressure below this limit will cause a start sequence abort.	25 psi
INJ FATAL LO = XXXX % OF DIS AIR	Selectable from 0 to 999 %. Determines minimum acceptable pressure limit for injection water as a percentage of discharge air pressure. Any pressure reading below this limit will cause a fatal shutdown of LPAC.	50 %
DIS AIR WARNING LO LIMIT = XXXX PSI	Selectable from 0 to 9999 psi. Determines lower limit of discharge air pressure. Any pressure reading below this limit will cause a discharge air low-pressure fault.	40 psi
DIS AIR FATAL LIMIT = XXXX PSI	Selectable from 0 to 9999 psi. Determines LPAC fatal pressure limit for compressor side of discharge air back-check valve. Reaching this limit will cause a fatal shutdown of LPAC.	140 psi
SHIP AIR LOW LIMIT = XXXX PSI	Selectable from 0 to 9999 psi. Determines lower limit of shipboard air pressure after LPAC has been running. Reaching this limit indicates an opening in shipboard air system not permitting pressure to rise.	20 psi

Table 1-3. Factory Preset Default Values (continued)

DEFAULT MESSAGE	PURPOSE	PRESET VALUE
SHIP AIR HI WARNING = XXXX PSI	Selectable from 0 to 9999 psi. Determines high limit for LPAC operation without operator warning. Reaching this limit will warn operator that expected high-pressure shutdown did not occur.	130 psi
INJECT LO TEMP WARN = XXXX DEG F	Selectable from 0 to 9999 degrees F. Determines lower fault trip point for injection water temperature.	40 degrees F
INJECT HI TEMP WARN = XXXX DEG F	Selectable from 0 to 9999 degrees F. Determines upper fault trip point for injection water temperature.	110 degrees F.
DIS AIR LO TEMP WARN = XXXX DEG F	Selectable from 0 to 9999 degrees F. Determines lower fault trip point for discharge air temperature.	40 degrees F.
DIS AIR HI TEMP WARN = XXXX DEG F	Selectable from 0 to 9999 degrees F. Determines upper fault trip point for discharge air temperature.	122 degrees F.
DIS AIR FATAL TEMP = XXXX DEG F	Selectable from 0 to 9999 degrees F. Determines fatal trip point for discharge air temperature. If reading is equal to or greater than this limit, a fatal LPAC shutdown will occur.	135 degrees F
SEAWATER OUT WARN = XXXX DEG F	Selectable from 0 to 9999 degrees F. Determines fault trip point for seawater outlet temperature.	102 degrees F
SEAWATER IN WARN = XXXX DEG F	Selectable from 0 to 9999 degrees F. Determines fault trip point for seawater inlet temperature.	95 degrees F
MAX DRAIN OPEN TIME = XXXX MIN	Selectable from 0 to 99 minutes. Determines number of minutes LPAC may run with drain solenoid valve open without receiving a mid-level moisture indication from separator level sensor. When this limit is reached, PLC will override normal level system and force tank drain solenoid closed.	2 minutes.

Table 1-3. Factory Preset Default Values (continued)

DEFAULT MESSAGE	PURPOSE	PRESET VALUE
LO LEVEL FAILS TO WARNING = XXXX	Selectable from 0 to 99 counts. Determines number of times a separator drain action can occur without returning a mid-level indication. If this count is matched or exceeded, a low-level fault indication is displayed.	1 count
MAX FILL OPEN TIME = XXXX MIN	Selectable from 0 to 99 minutes. Determines number of minutes LPAC may run with make-up solenoid valve open without receiving a mid-level moisture indication from separator level sensor. When limit is reached, PLC will override normal level system and force make-up solenoid valve closed.	5 minutes
HI LEVEL FAILS TO WARNING = XXXX	Selectable from 0 to 99 counts. Determines number of times tank level make-up action can occur without returning a mid-level indication. If count is matched or exceeded, a high-level fault indication will be displayed.	1 count
AIR FILTER ALARM = XXXX HRS	Selectable from 1 to 9999 hours. Determines when warning message for air filter replacement will be displayed as a fault. Total time is determined as LPAC run hours only, not PLC run hours.	
WATER FILTER ALARM = XXXX HRS	Selectable from 1 to 9999 hours. Determines when warning message for water filter replacement will be displayed as a fault. Total time is determined as LPAC run hours only, not PLC run hours.	1000 hours
GENERAL MAINT ALARM = XXXX HRS	Selectable from 1 to 9999 hours. Determines when warning message for general LPAC maintenance will be displayed as a fault. Total time is determined as LPAC run hours	1000 hours

Table 1-3. Factory Preset Default Values (continued)

DEFAULT MESSAGE	PURPOSE	PRESET VALUE
OVERHAUL MAIN ALARM = XXXX HRS	Selectable from 1 to 9999 hours. Determines when warning for LPAC overhaul will be displayed as a fault. Total time is determined as LPAC run hours only, not PLC run hours.	5000 hours
INLET TEMP 1ST READ = XXXX MIN.	Selectable from 0 to 99 minutes. Determines when first comparison of LPAC inlet temperature with preset limits will occur. Delay necessary to avoid false alarms when LPAC has been shut down for a short duration and then restarted.	3 minutes
UNLOAD MAX. RUN TIME = XXXX MIN.	Selectable from 0 to 99 minutes. Determines total time from unload run mode start until compressor is finally shut down. A demand for air during this time will cause LPAC to return to loaded run mode.	10 minutes
SHIP PRESS RISE DELAY = XXXX MIN.	Selectable from 0 to 99 minutes. Determines delay time from LPAC start until shipboard air pressure must show a rise. This warning exists to alert operator that shipboard air system may be open to atmosphere.	10 minutes
PRINT-OUT CYCLE TIME = XXXX MIN.	Selectable from 0 to 99 minutes. Determines PLC printer cycle time. At end of specified time PLC will print a list of all monitored LPAC pressures and temperatures	60 minutes

CHAPTER 2
OPERATION

2-1. INTRODUCTION.

This chapter provides procedures for start up, automatic, manual, and emergency operation of the model STAR 200 low-pressure air compressor (LPAC). It also identifies the use and function of all operator controls and indicators. Illustrations are included to aid in the location of controls, valves, gauges and displays.

2-2. SAFETY REQUIREMENTS.

Prior to operating the STAR 200 LPAC, personnel should review and become thoroughly familiar with the general precautions listed in the safety summary. Operating procedures, together with their specific Warnings, Cautions and Notes, should be read prior to operating the LPAC.

2-3. CONTROLS AND INDICATORS.

2-3.1 Operator Controls. Table 2-1 describes the operator controls and indicators, which will be discussed in paragraph 2-4. Refer to Figure 2-1 to locate compressor management system (CMS) and programmable logic controller (PLC) controls and indicators. Refer to Figure 2-2 for controls and indicators located elsewhere on the LPAC.

NOTE

When the PLC detects a condition that could cause damage to the LPAC, the PLC stops the LPAC and displays a maintenance alert message preceded by the word "FATAL". All fatal conditions must be corrected before the LPAC is restarted. The PLC must be reset by pressing the STOP/RESET pushbutton switch.

2.3.2 PLC Indicators. During normal operations, the PLC displays both operational and maintenance alert messages on a touchscreen display (3, Figure 2-1). Messages of interest to the operator are explained in Table 2-1. Other messages displayed are intended to alert maintenance personnel to a LPAC malfunction. Maintenance alert messages should be referred to maintenance personnel for investigation in accordance with Chapter 5. Refer to Figure 2-4 for PLC messages.

2-4. OPERATING PROCEDURES.

2-4.1 Start Up. The LPAC is designed for fully automatic operation following start up. It is also capable of manual or emergency operation. Procedures for initial start up on a new LPAC installation are covered in Chapter 8 of this manual. Table 2-2 lists the procedures to be followed prior to any start up of the LPAC.

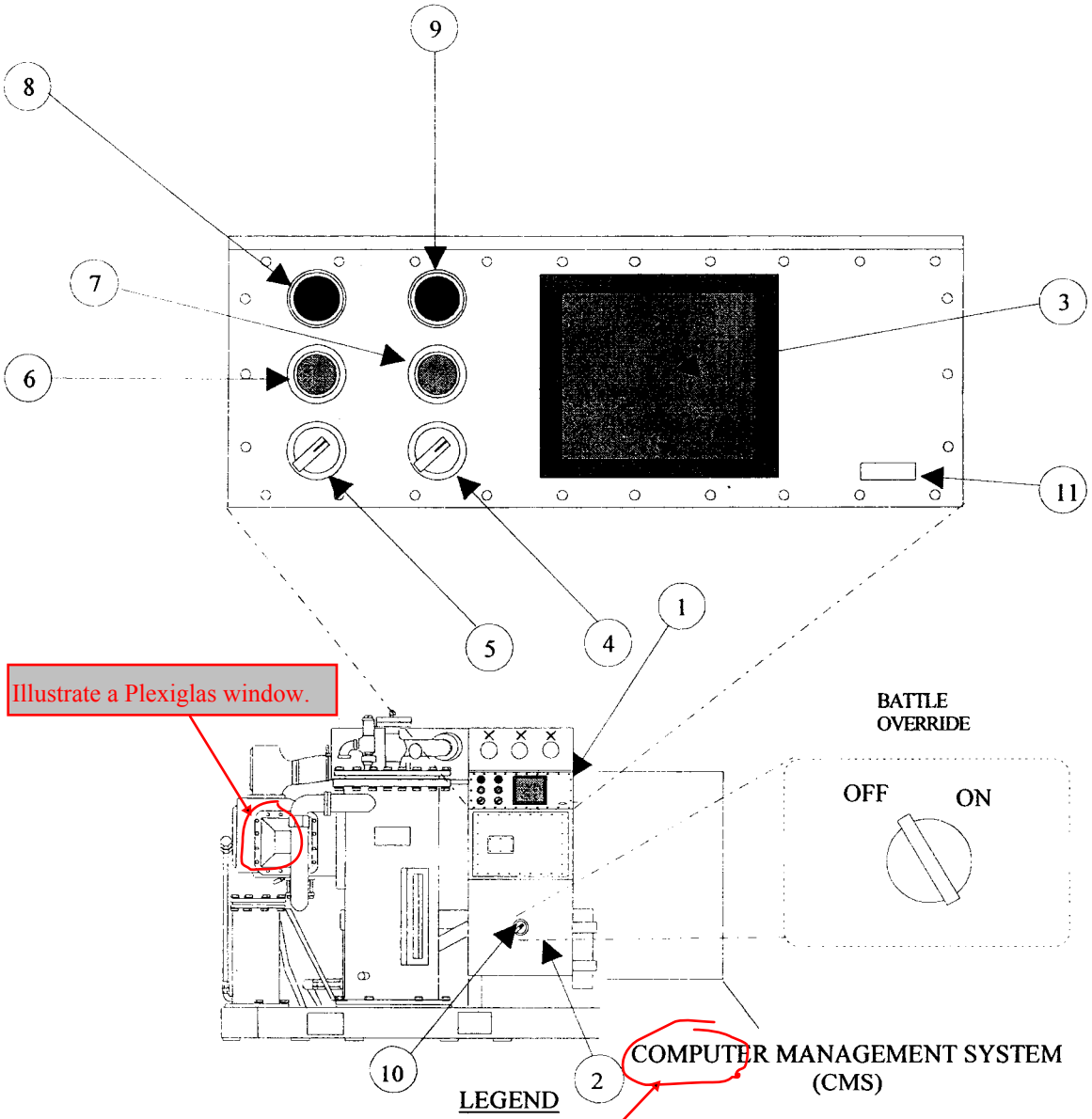
2-4.2 Automatic Operation. In the automatic mode the CMS monitors and controls the LPAC operation. The LPAC will self-start each time system pressure drops to the default low-pressure setting. It will run until the system pressure reaches the default high-pressure setting. When the CMS detects that the system pressure has reached the default high-pressure setting, it will switch to 10 minutes of standby operation. If the system pressure drops to the default low-pressure setting during the 10-minute unloaded operation procedure, the LPAC will return to full operation. If not, the CMS will stop the LPAC.

2-4.2.1 PLC Monitoring in Automatic Operation. The PLC also monitors LPAC operation and sequentially displays the monitored values. If the PLC detects that a default value which could damage the LPAC has been exceeded, it will automatically stop the LPAC and display a fatal fault message.

2-4.2.2 PLC Control During Automatic Operation. During automatic operation, with the Battle Override Switch (10, Figure 2-1) set to OFF, the PLC monitors the separator assembly water level and automatically maintains it within limits. In the automatic mode, operator tasks are limited to periodically monitoring indicators, gauges and PLC displays. The LPAC can be manually stopped during automatic operation by pressing the STOP/RESET pushbutton switch (7, Figure 2-1). When the STOP pushbutton is pressed to halt operation in the AUTO mode, a FAULTED shutdown will occur, and then the display will show the message "**SET TO MANUAL THEN PRESS RESET**." This prevents re-starting of the compressor until the STOP/RESET pushbutton switch (7, Figure 2-1) is pressed.

2-4.2.3 PLC Battle Override Operation. During operation with the Battle Override Switch (10, Figure 2-1), the CMS relinquishes control over operations to be manually controlled by the operator. Refer to Section 2-4.4 for more details. When BATTLE OVERRIDE mode is initiated, a summary fault message is sent to the ship's bridge monitor to notify command of run mode change.

Bridge signal???



LEGEND

1. PROGRAMMABLE LOGIC CONTROLLER (PLC)
2. HIGH VOLTAGE ENCLOSURE
3. PLC TOUCHSCREEN DISPLAY
4. MAN/AUTO SELECTOR SWITCH
5. CONTROL POWER ON/OFF SELECTOR SWITCH
6. START PUSHBUTTON SWITCH
7. STOP/RESET PUSHBUTTON SWITCH
8. POWER INDICATOR LIGHT
9. WARNING FAILURE LIGHT

Change "Computer" to "Compressor". CMS was established in Paragraph 1-3.1 and Chapter 1 Figures 1-1 and 1-2 as "Compressor Management System".

Figure 2-1 Computer Management System (CMS)

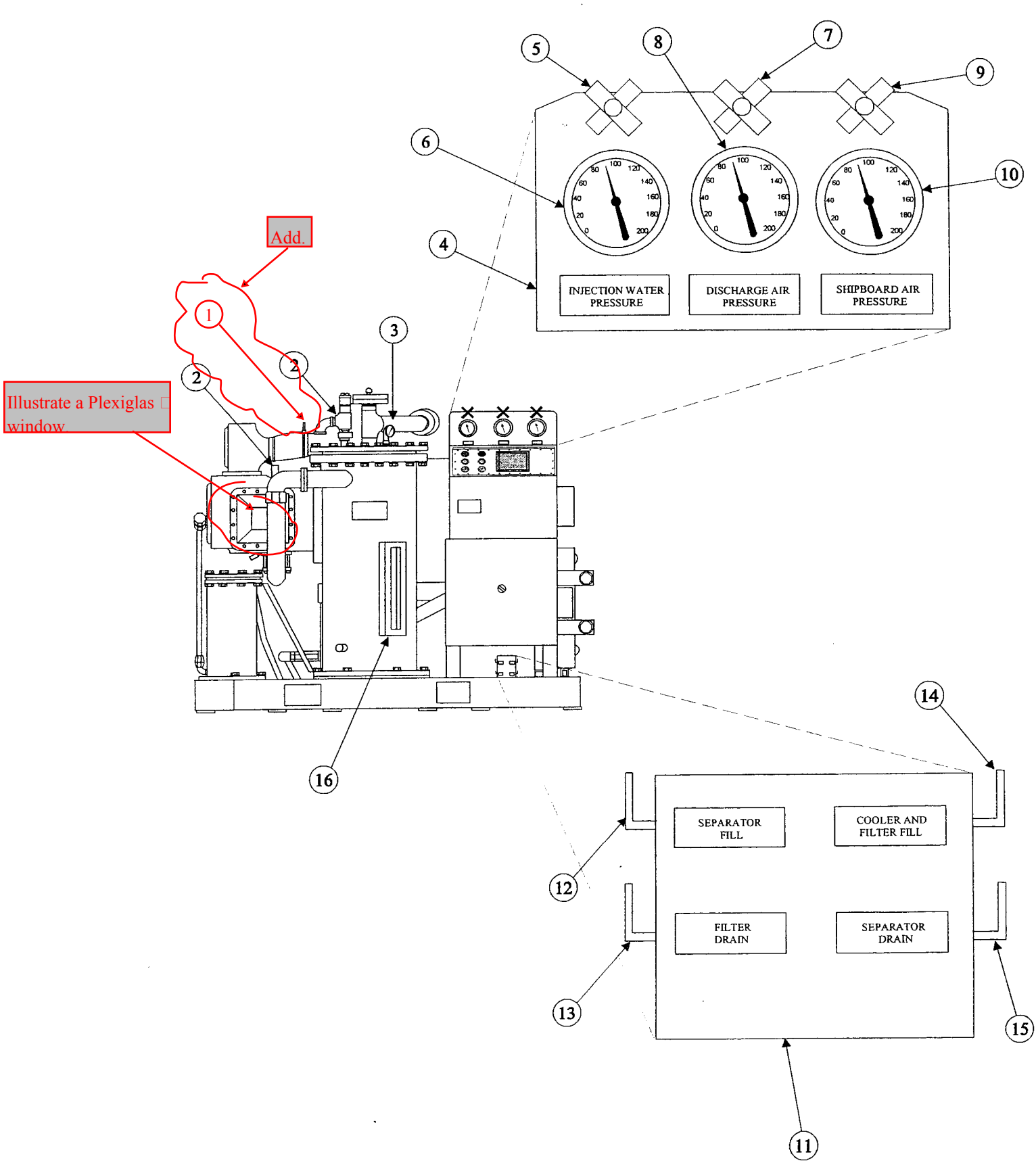
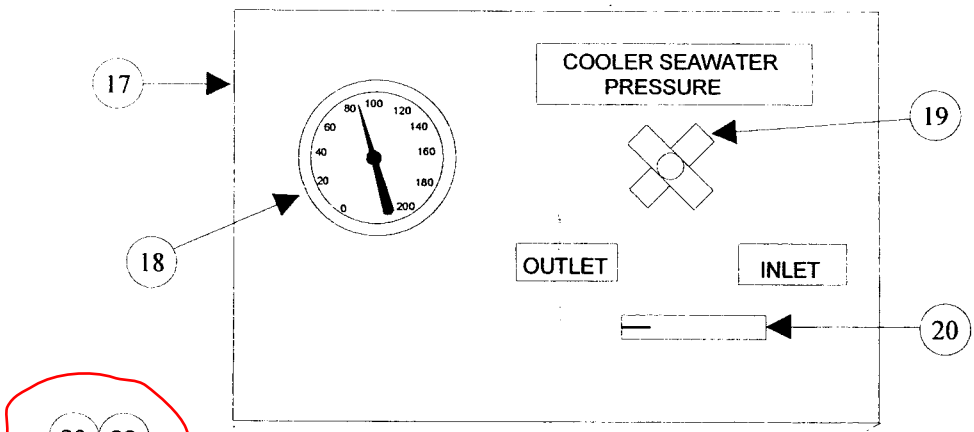
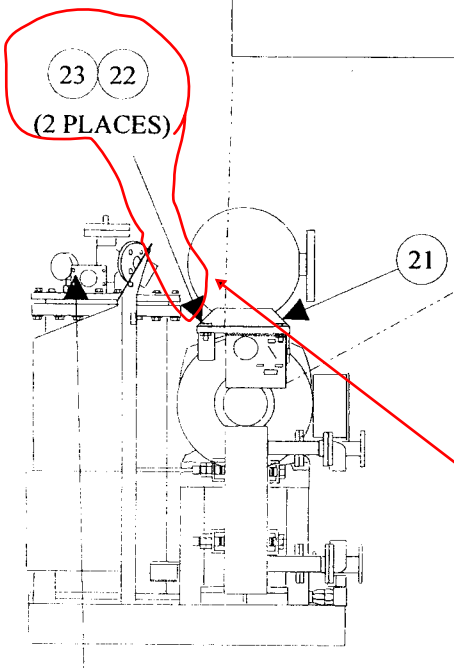


Figure 2-2. Miscellaneous Controls and Indicators (Sheet 1 of 2)





Delete. Re: Items 22 and 23 are not controls or indicators.

Change "24" to "22".

LEGEND

1. AIR FILTER PRESSURE DROP POP-UP INDICATOR
2. HIGH-PRESSURE RELIEF VALVE
3. DISCHARGE AIR TEMPERATURE GAUGE
4. GAUGE PANEL
5. INJECTION WATER PRESSURE GAUGE
6. VALVE
7. PRESSURE GAUGE
8. DISCHARGE AIR PRESSURE GAUGE
9. SHIPBOARD AIR PRESSURE GAUGE
10. VALVE
11. SHIPBOARD AIR PRESSURE GAUGE
12. MAKE-UP AND DRAIN VALVE MANIFOLD BLOCK
13. SEPARATOR FILL VALVE
14. FILTER DRAIN VALVE
15. COOLER AND FILTER FILL VALVE
16. SEPARATOR DRAIN VALVE
17. WATER LEVEL SIGHT GLASS
18. SEAWATER GAUGE PANEL, part of (21)
19. COOLER SEAWATER PRESSURE GAUGE
20. COOLER SEAWATER PRESSURE GAUGE
21. COOLER SEAWATER PRESSURE GAUGE SELECTOR VALVE
22. AIR FILTER BRACKET, includes GAUGE
23. SCREW
24. NUT
    DIFFERENTIAL PRESSURE GAUGE

Figure 2-2. Miscellaneous Controls and Indicators (sheet 2 of 2)

Table 2-1 is incomplete. Expand Table 2-1in the Description and Function columns to include the controls and indicators (Items 1-11) listed in the Legend of Figure 2-1. Refer to LPAC Equipment T/M S6220-EE-MMA-010 (Chg. F), Table 2-1. See Attached.

Table 2-1. Operator Controls and Indicators

Description	Function
PLC Unit (Figure 2-1)	Monitors and controls the LPAC.
Elsewhere on the LPAC (Figure 2-2)	
Injection Water Pressure Gauge (6)	Indicates the pressure of the potable (fresh) water being injected into air end of the LPAC. Normal reading is greater than 55 pounds per square inch gauge (psig).
Injection Water Pressure Gauge Valve (5)	When closed, isolates the INJECTION WATER PRESSURE gauge and transducer from the injection water loop. Normal position is OPEN.
Discharge Air Pressure Gauge (8)	Indicates the pressure of the air at the discharge side of the separator assembly. Normal reading is below 125 psig.
Discharge Air Pressure Gauge Valve (7)	When closed, isolates the DISCHARGE AIR PRESSURE gauge and transducer from the discharge air loop. Normal position is OPEN.
Shipboard Air Pressure Gauge (10)	Indicates the air pressure at the ship's low-pressure (LP) air system accumulator. Normal reading is below 125 psig.
Shipboard Air Pressure Gauge Valve (9)	When closed, isolates the SHIPBOARD AIR PRESSURE gauge and transducer from the shipboard LP air system. Normal position is CLOSED.
Separator Fill Valve (12)	When opened, adds make-up potable water to the separator assembly. Normal position is OPEN.
Separator Drain Valve (15)	When opened, drains potable water from the separator assembly. Normal position is CLOSED.
Cooler & Filter Fill Valve (14)	When opened, adds potable water to the water filter assembly and potable waterside of the heat exchanger and associated water piping. Normal position is CLOSED.
Filter Drain Valve (13)	When opened drains potable water from the water filter assembly, potable waterside of the heat exchanger and associated water piping. Normal position is CLOSED.
Change "24" to "22".	
Differential Pressure Gauge (24)	The gauge is piped to both sides of the flow orifice in the air discharge. The gauge reading equates to the compressor airflow.
Air Filter Pressure Drop Pop-Up Indicator (1)	Pops-up to indicate a restriction of airflow through the air inlet filter. Normal position is RETRACTED.

Revise Table 2-1 to reflect Table 2-1 from T/M S6220-EE-MMA-010 (Chg. F), Table 2-1. See attached.

Table 2-1. Operator Controls and Indicators (continued)

Water Level Sight Glass (16)	**NOTE** During compressor operation foaming has, on occasion, occurred in the closed loop potable water system. When this happens there is no longer a discernible water level in the separator sight glass but rather a steady stream of what appears to be foam. A foaming condition can lead to faulty operation of the level sensors in the separator tank and also water carryover into the discharge piping. If foaming is encountered, the potable water should be drained using the FILTER DRAIN and SEPARATOR DRAIN manual valves. Remove water filter vent plug (12, Figure 6-17) and add approximately three (3) tablespoons or 1.5 ounces of antifoam agent through vent port. Replace vent plug and refill potable water (IAW Table 2-2).
	Delete.
	NOTE lly sight the water level in the separator nal indication is with the water level and high levels (in "NORMAL" level band on separator water level gauge).
Move up the Description column text to align with the Function column line items.	
Discharge Air Temperature Gauge (3)	Indicates the temperature of the air being discharged to the ship's LP air system accumulator. Normal reading is below 122 degrees F.
Cooler Seawater Pressure	Indicates seawater pressure at either the inlet or the outlet side gauge (18) of the heat exchanger (depending on the selector valve (20) position). Normal inlet reading is 20 to 175 psig. Normal outlet reading is less than 15 psig below the inlet reading.
Cooler Seawater Pressure	Connects the COOLER SEAWATER PRESSURE gauge, gauge selector valve INLET/OUTLET (20) to the inlet or outlet side of the heat exchange seawater loop. Normal setting is INLET.
Cooler Seawater Pressure Gauge	When closed, isolates COOLER SEAWATER valve (19) PRESSURE gauge from the seawater loop. Normal position is OPEN.

2-4.3 Manual Operation. The manual mode only affects the starting of the LPAC. It is used when start up of the LPAC must be controlled by the operator, such as during maintenance. The manual mode is initiated by setting the MAN/AUTO selector switch (4, Figure 2-1) to MAN. In the manual mode the LPAC will only start when the START pushbutton switch (6, Figure 2-1) is pressed. Once started manually, the LPAC will run until either the PLC detects the system air pressure has reached the default high-pressure limit, which will automatically initiate shutdown of the LPAC, or the STOP/RESET pushbutton switch (7, Figure 2-1) is pressed. In either situation, the LPAC will go through a 30 second air-head drain cycle after stopping. It will not go the 10 minute unloaded operation cycle. In manual operation mode, the operator is required to monitor the SHIPBOARD AIR PRESSURE gauge (10, Figure 2-2) and manually start the LPAC each time air is required. Table 2-4 lists the procedures for operating in the manual mode.

2-4.3.1 PLC Monitoring During Manual Operation Mode. The PLC also monitors LPAC operation and sequentially displays the monitored values. If the PLC detects that a default value which could damage the LPAC has been exceeded, it will automatically stop the LPAC and display a fault message.

2-4.3.2 PLC Control During Manual Operation Mode. During automatic operation, with the Battle Override Switch (10, Figure 2-1), the PLC monitors the separator assembly water level and automatically maintains it within limits. In the automatic mode, operator tasks are limited to periodically monitoring indicators, gauges and PLC displays. The LPAC can be manually stopped during automatic operation by pressing the STOP/RESET pushbutton switch (7, Figure 2-1). When the STOP pushbutton switch is used to halt operation in the AUTO mode, a FAULTED shutdown will occur, and then the display will show the message "**SET TO MANUAL THEN PRESS RESET**." This prevents re-starting of the compressor until the RESET pushbutton switch has been pressed, clearing the fault.

2-4.4 Emergency (Battle Override) Operation.

CAUTION

No safeties are active during Battle Override Operation. It does not monitor or shutdown for any compressor failure. The water level must be manually controlled by an operator.

CAUTION

During Battle Override Operation, the only way to shut down the LPAC is by positioning the battle override selector switch to OFF.

Insert "or secure power at the breaker".

In the BATTLE OVERRIDE mode, the operator controls all LPAC functions to maintain the separator assembly water level. This mode is used in an emergency whenever the failure of system or LPAC components prevents either automatic or manual operation, or as crisis situations dictate. The BATTLE OVERRIDE mode is initiated by pulling out the locking attachment and positioning the BATTLE OVERRIDE switch to ON (10, Figure 2-1). This starts the LPAC. The LPAC will run until the BATTLE OVERRIDE switch (10, Figure 2-1) is positioned to OFF. During BATTLE OVERRIDE operation the PLC will continue to monitor and display LPAC operational data to the extent allowed by the failure. The PLC will control neither the LPAC operation nor the separator assembly water levels. When stopped in BATTLE OVERRIDE mode, the LPAC does not go through an air-head drain cycle or unloaded operation period. BATTLE OVERRIDE operation requires constant attendance by the operator and manual control of all applicable functions (including the separator assembly water level). Table 2-5 lists the procedures for operating in the BATTLE OVERRIDE mode.

The BATTLE OVERRIDE switch is not a two position toggle switch. Revise the sentence to reflect a two position rotary snap switch.

2-4.5 Emergency Shutdowns. In event of fire, flooding hazard to personnel, loss of coolant, or other similar emergency, shutdown the LPAC as follows:

a) Set MAN/AUTO selector switch (4, Figure 2-1) to MAN.

b) If no normal mode of operation occurs, press STOP/RESET pushbutton switch (7, Figure 2-1).

c) If in battle override mode of operation and LPAC is running, position BATTLE OVERRIDE switch (10, Figure 2-1) located on high voltage enclosure (2, Figure 2-1) to OFF. The locking attachment must be pulled out to change switch positions.

CAUTION

Always put controller in manual Mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place the controller in that mode when power is restored. This can allow uncontrolled LPAC start-up after power restoration.

d) Secure LPAC electrical power supply at source in accordance with ship's requirements.

e) Close valves supplying seawater to LPAC.

f) Close valves supplying potable water to LPAC.

g) Isolate LPAC from shipboard LP air system.

2-5. SETTING THE LPAC OPERATING PRESSURE LIMITS.

2-5.1 Selecting a Default Pressure Range Value. The PLC has three preset operating pressure ranges, which can be selected by the operator. They are: 105-115 psig, 110-120 psig, and 115-125 psig. Refer to Figure 2-4.11.

2-5.2 Setting A Custom Pressure Range Value. The PLC can be set to operate at a custom pressure (other than those described in Paragraph 2-5.1 above). The PLC can be set to any value up to 125 psig. The only restriction is that the low limit must be lower than the upper limit.

NOTE

The LPAC upper limit should never be set above 125 psig. The LPAC's high-pressure relief valve restricts the LPAC's upper pressure limit to 150 psig.

2-6. OPERATOR'S MAINTENANCE INSTRUCTIONS AND SCHEDULES.

Operator maintenance is limited to keeping the equipment and surrounding area clean, and responding to the PLC generated messages and warning indicators. Maintenance should be handled IAW Chapter 4 (which contains scheduled maintenance requirements), Chapter 5 (evaluation of alert messages), and Chapter 6 (procedures for correcting maintenance problems).

2-7. STANDARD LOG SHEET.

Figure 2-3 is the standard log sheet for recording LPAC readings. The sheet lists all items that require recording. The completed log sheets should be analyzed for operating trends requiring maintenance investigation.

2-8. TRAINING SUMMARY.

Readings should be recorded on the standard log sheet (Figure 2-3) every four hours to indicate the status of the air compressor. Readings that are not within the minimum/maximum range will be checked and maintenance action will be taken as appropriate (IAW Chapters 5 and 6).

LOW PRESSURE AIR COMPRESSOR
Standard LOG SHEET

DATE:	NORMAL	LIMIT	1	2	3	4	5	6
RECORDED BY:								
TIME:								
HOURMETER:								
P1 - INJ WATER								
P2 - DISCHARGE AIR								
P3 - SHIPBOARD AIR	105 - 125	20/130**						
P4 - SW IN (GAUGE)	20 - 175							
P5 - SW OUT (GAUGE)	20 - 175							
T1 - INJ WATER	40 - 105	40/110**						
T2 - DISCHARGE AIR	40 - 120	40:122/135***						
T3 - SW IN	28 - 95	95**						
T4 - SW OUT		102**						
TANK LEVEL	NORMAL	LL/HH****						
RPM	3565	3600						
VOLTS	440							
AMPS		68.5						
FLOW	200							

Add P6 and P7 line items for Air Filter Vacuum and SW Strainer differential pressures. Refer to LPAC Equipment T/M S6220-EE-MMA-010 (Chg. F), Figure 2-3. See Attached.

* Causes shutdown

** Causes warning

*** Causes warning/shutdown (Example: 40:122/135: warning at 40 or 122 deg. F, shutdown at 135 deg. F)

**** During compressor operation foaming has, on occasion, occurred in the closed loop potable water system. When this happens there is no longer a discernible water level in the water level sight glass but rather a steady stream of what appears to be foam. A foaming condition can lead to faulty operation of the level sensors in the separator tank and also water carryover in to the discharge piping. If foaming is encountered the potable water should be drained using the FILTER DRAIN and SEPARATOR DRAIN manual valves. Remove water filter vent plug (12, Figure 6-17) and add approximately three (3) tablespoons or 1.5 ounces of antifoam agent through vent port. Replace vent plug and refill potable water (IAW Table 2-2).

COMMENTS:

Figure 2-3. Standard Log Sheet

Align line item Table data in the Step, Action and Indication columns as indicated. Refer to LPAC Equipment T/M S6220-EE-MMA-010 (Chg. F), Table 2-2. See Attached.

Step		cation
1.	Assume no maintenance is being performed on associated LP air system.	No equipment valves or electrical circuits tagged "OUT OF SERVICE."
2.	Visually inspect LPAC piping, wiring and area.	All pipe joints tight without signs of leaks. All wiri All cove Area free of loose objects.
3.	Check associated ship's seawater and potable water valves properly aligned.	a) No sign of fluid leaks. b) Va ex heat
4.	Check INJECTION WATER, DISCHARGE AIR, SHIPBOARD AIR, and COOLER SEAWATER pressure gauge valves (5, 7, 9 and 19, Figure 2-2, respectively) open.	Valves in piping supplying potable water to LPAC open. Valves in piping from LPAC seawater and potable water drains open.
5.	Ensure seawater being supplied to heat exchanger.	Inlet pressure (25 - 175 psi) should be observed on cooler seawater pressure gauge (18, Figure 2-2) when selector (20, Figure 2-2) is set to INLET.
6.	Open COOLER AND FILTER FILL valve (14, Figure 2-2) to top off potable water loop. Close valve when loop full.	No water flow through loop piping should be felt when loop full.
7.	Check WATER LEVEL SIGHT GLASS (16, Figure 2-2) for proper separator assembly water level. If Low: Open SEPARATOR FILL valve (12, Figure 2-2). Close valve when water level rises above low level. If High: Open SEPARATOR DRAIN valve (15, Figure 2-2). Close valve when water level drops below high level.	Water level should be between low and high levels (3/8 full to 7/8 full in sight glass).
8.	Set MAN/AUTO selector switch (4, Figure 2-1) to MAN. Then set ON/OFF selector switch (5, Figure 2-1) to ON.	PLC touchscreen display (3, Figure 2-1) displays: "COMPRESSOR READY FOR START."

Add letters a-d to alphabetize each line description.

Add "c)" before the word "Valves".

Table 2-3. Automatic Operation Procedures

NOTE

When the STOP/RESET pushbutton is pressed to halt operation in the AUTO mode, a FAULTED shutdown will occur, and then the display will show the message "**SET TO MANUAL THEN PRESS RESET**." This prevents re-starting of the compressor until the STOP/RESET pushbutton has been pressed again, clearing the fault.

NOTE

Prior to starting in automatic mode, check the SHIPBOARD AIR PRESSURE gauge (10, Figure 2-2). System pressure must be below the preset high-pressure setting before the LPAC will start.

NOTE

Automatic operation may be terminated at any time by setting the MAN/AUTO selector switch (4, Figure 2-1) to MAN and pressing the STOP/RESET pushbutton switch (7, Figure 2-1).

Step	Action	Indication
1.	Perform all steps of Pre-start Procedures listed in Table 2-2.	
2.	Set MAN/AUTO selector switch (4, Figure 2-1) to AUTO.	When system pressure drops to default low pressure limit the following occurs in sequence: a) PLC touchscreen display (3, Figure 2-1) displays "COMPRESSOR START-UP ACTIVATED" b) Make-up, unloader and shut-off solenoids energize. c) Main contact closure delay timer starts. d) Main contactor closes on completion of delay e) Make-up solenoid de-energizes f) PLC touchscreen display (3, Figure 2-1) displays "NORMAL START-UP COMPLETED" g) MOTOR RUNNING indicator light (8, Figure 2-1) glows green. h) HOURS meter (11, Figure 2-1) starts to run. i) PLC touchscreen display (3, Figure 2-1) begins sequentially displaying LPAC operating data. j) LPAC will cycle on and off as default high and low system pressure limits are sensed by the PLC.

Table 2-3. Automatic Operation Procedures (continued)

Step	Action	Indication
3. (cont.)	Periodically go to the LOG DATA screen (Figure 2-4.3) to display operating parameters.	PLC touchscreen display (3, Figure 2-2) displays monitored LPAC sensor readings and compressor status as shown in the LOG DATA screen (Figure 2-4.3).
4.	Periodically check LPAC cyclic operation. PLC should initiate LPAC unloading when SHIPBOARD AIR PRESSURE gauge (10, Figure 2-2) reads the default high-pressure limit.	a) PLC touchscreen display (3, Figure 2-1) displays "COMPRESSOR RUN MODE=UNLOADED". b) LPAC operates unloaded (50 psig) for 10 minutes or alternate time programmed into the PLC. c) LPAC stops if no demand is detected during 10 minute unloaded operation period. d) PLC touchscreen display (3, Figure 2-1) displays "AIR-HEAD AINING IN PROGRESS" for 30 seconds. TOR RUNNING indicator light (8, Figure 2-1) glows green. f) HOURS meter (11, Figure 2-1) stops running.
5.	PLC should start LPAC each time SHIPBOARD AIR PRESSURE gauge (10, Figure 2-2) reading drops to default low-pressure limit.	g) LPAC drive motor (Figure 1-2) starts. h) MOTOR RUNNING indicator light (8, Figure 2-1) glows green. i) HOURS meter (11, Figure 2-3) start running.
6.	Periodically check LPAC operation as displayed on PLC touchscreen display (3, Figure 2-1) standard log sheet (Figure 2-3).	Recorded readings should be within limits shown on standard log sheet (Figure 2-3).
7.	Periodically check separator assembly water level.	During compressor operation foaming has, on occasion, occurred in the closed loop potable water system. When this happens there is no longer a discernible water level in the water level sight glass but rather a steady stream of what appears to be foam. A foaming condition can lead to faulty operation of the level sensors in the separator tank and also water carryover into the discharge piping. If foaming is encountered the potable water should be drained using the FILTER DRAIN and SEPARATOR DRAIN manual valves. Remove water filter vent plug (12, Figure 6-17) and add approximately three (3) tablespoons or 1.5 ounces of antifoam agent through vent port.

Delete.

Move up.

Renumber subsequent steps.

Table 2-3. Automatic Operation Procedures (continued)

Step	Action	Indication
7. (cont.)		Replace vent plug and refill potable water (IAW Table 2.2). The PLC should automatically maintain separator water level between 3/8 and 7/8 full in water level sight glass (16, Figure 2-2).
8.	Periodically check LPAC for air or fluid leaks.	
9.	On completion of automatic operation, after 10 minutes of unloaded running, the LPAC will shutdown until further demand for pressure.	The following occurs in sequence: a) Shut-off solenoid is deactivated. b) PLC touchscreen display (3, Figure 2-1) displays "MAIN CONTACTOR SHUT DOWN" c) Remaining solenoids de-energize. d) LPAC stops and PLC touchscreen display (3, Figure 2-1) displays "SHUTDOWN COMPLETE" for 5 seconds. e) For 30 seconds PLC touchscreen display (3, Figure 2-1) displays "AIR-HEAD DRAINING IN PROGRESS." f) MOTOR RUNNING indicator light (8, Figure 2-1) goes off. g) PLC touchscreen display (3, Figure 2-1) displays "COMPRESSOR READY FOR START." ***CAUTION*** Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.
10.	Set ON/OFF selector switch (5 Figure 2-1) to OFF.	PLC touchscreen display (3, Figure 2-2) blanks.

Table 2-4. Manual Operation Procedures

NOTE

During the described manual operation procedures the LPAC must be started manually each time make-up air is required. It may either be stopped manually when make-up air is no longer required or left for automatic shutdown by the PLC when the default high-pressure limit is sensed.

	Action	Indication
1.	Perform all steps of Pre-start Procedures listed in Table 2-2.	
2.	Set MAN/AUTO selector switch (4, Figure 2-1) to MAN.	
3.	Each time shipboard system requires air, press START pushbutton switch (6, Figure 2-1).	Following events occur in sequence: a) PLC touchscreen display (3, Figure 2-1) displays "COMPRESSOR START-UP ACTIVATED." b) Make-up, unloader and shut-off solenoids energize. c) Main contactor closure delay timer starts. d) After 2 second delay, to inject potable water into the compressor assembly air end, the main contactor closes and the LPAC starts. e) Make-up solenoid de-energizes. f) PLC touchscreen display (3, Figure 2-1) displays "NORMAL START-UP COMPLETED." g) MOTOR RUNNING indicator light (8, Figure 2-1) glows green. h) HOURS meter (11, Figure 2-1) starts to run. i) PLC touchscreen display (3, Figure 2-1) will begin displaying LPAC operating data. j) LPAC will continue to run until either the PLC senses that system pressure is at the preset high-pressure setting or the STOP/RESET pushbutton switch (7, Figure 2-1) is pressed.
4.		***CAUTION*** Internal compressor assembly components are lubricated by injected potable water. Operating LPAC with either excess or low separator assembly water levels can damage compressor assembly components and cause premature failure of LPAC.

Table 2-4. Manual Operation Procedures (continued)

Step	Action	Indication
4. (cont.)	Periodically check the water level sight glass (16, Figure 2-2)	During compressor operation foaming has, on occasion, occurred in the closed loop potable water system. When this happens there is no longer a discernible water level in the separator sight glass but rather a steady stream of what appears to be foam. A foaming condition can lead to faulty operation of the level sensors in the separator tank and also water carryover into the discharge piping. If foaming is encountered the potable water should be drained using the FILTER DRAIN and SEPARATOR DRAIN manual valves. Remove water filter vent plug (12, Figure 6-17) and add approximately three (3) tablespoons or 1.5 ounces of antifoam agent through vent port. Replace vent plug and refill potable water (IAW Table 2-2). PLC should maintain level between the low and high water level (3/8 full to 7/8 full in sight glass). **NOTE** If the water level exceeds either the low-level or high-level warning levels, follow the process outlined in Section 2-4.5.1 to manually balance the water level. Continue to operate the LPAC in manual mode and initiate a maintenance check.
5.	Periodically check LPAC operation as displayed on PLC touchscreen display (3, Figure 2-1). **NOTE** Refer to standard log sheet (Figure 2-3, page 2-9) for normal values of operation.	PLC touchscreen display (3, Figure 2-1) displays monitored LPAC sensor readings in following sequence: "INJ FRESHWATER PRESS = XXXX PSI" "DISCHARGE AIR PRESS = XXXX PSI" "SHIPBOARD AIR PRESS = XXXX PSI" "SEAWATER DISCHARGE TEMP = XXXX F" "SEAWATER INLET TEMP = XXXX F" "DISCHARGE AIR TEMP = XXXX F" "INJ FRESHWATER TEMP = XXXX F"
	Periodically check LPAC operation as displayed on PLC touchscreen display (3, Figure 2-1).	PLC touchscreen display (3, Figure 2-1) displays monitored LPAC sensor readings in following sequence: "TANK LEVEL = XXXXXXXXX" "COMPRESSOR STARTS = XXXX" "LOADED RUN HOURS = XXXX" "COMPRESSOR RUN HOURS = XXXX" "PRESSURE RANGE XXX TO XXX PSI" "COMPRESSOR RUN MODE XXXXXXX"
6.	Repeat steps 3, 4, and 5.	

Table 2-4. Manual Operation Procedures (continued)

Step	Action	Indication
7.	On completion of manual operation press STOP/RESET pushbutton switch (7, Figure 2-1) to reset compressor.	Following occurs in sequence: a) Shut-off solenoid de-energizes. b) PLC touchscreen display (3, Figure 2-1) displays "MAIN CONTACTOR SHUT-DOWN." c) LPAC stops. d) Remaining solenoids de-energize. e) PLC touchscreen display (3, Figure 2-1) displays: "SHUT-DOWN COMPLETE" for 5 seconds "AIR-HEAD DRAINING IN PROGRESS" for 30 seconds "COMPRESSOR READY FOR START"
8.		***CAUTION*** Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.
	Set ON/OFF selector switch (5, Figure 2-1) to OFF.	PLC touchscreen display (3, Figure 2-1) blanks.

Table 2-5. Battle Override Operation Procedures

Insert "or secure power at the breaker".

CAUTION

During battle override operation, the only way to shut down the LPAC is by positioning the BATTLE OVERRIDE switch to the OFF position.

CAUTION

If INJECTION WATER PRESSURE gauge (6, Figure 2-2) fails to read a minimum of 25 psig within 10 seconds of starting the LPAC in BATTLE OVERRIDE mode, stop the LPAC by setting the ON/OFF selector switch (5, Figure 2-1) to the OFF position. Continued operation with low injection water pressure can damage LPAC.

NOTE

During emergency operations the PLC acts as a monitor only. No safeties are active during BATTLE OVERRIDE Operation. The PLC does not exercise any control of compressor operation. Manual control of the SEPARATOR ASSEMBLY water level must be maintained by the operator.

Table 2-5. Battle Override Operation Procedures (continued)

Step	Action	Indication
1.	Perform all steps of Pre-start Procedures listed in Table 2-2.	
2.	Set MAN/AUTO selector switch (4, Figure 2-1) to MAN.	
3.	Monitor SHIPBOARD AIR PRESSURE gauge (10, Figure 2-2).	
	a) Turn the BATTLE OVERRIDE SWITCH to the ON position (10, Figure 2-1) each time system requires air. The locking attachment must be pulled out to change positions.	a) LPAC starts. b) PLC touchscreen display (3, Figure 2-1) displays "BATTLE OVERRIDE ACTIVE."
	b) Each time system air requirements are satisfied, return the BATTLE OVERRIDE SWITCH to the OFF position (10, Figure 2-1).	a) LPAC stops. b) PLC touchscreen display (3, Figure 2-1) stops displaying "BATTLE OVERRIDE ACTIVE". c) PLC touchscreen display (3, Figure 2-1) displays "BATTLE OVERRIDE DELAY ACTIVE."
4.		***CAUTION*** Internal compressor assembly components are lubricated by injected potable water. Operating LPAC with either excess or low separator assembly water levels can damage compressor assembly components and cause premature failure of LPAC.
	Check water level sight glass (16, Figure 2-2).	**NOTE** During compressor operation foaming has, on occasion, occurred in the closed loop potable water system. When this happens there is no longer a discernible water level in the separator sight glass but rather a steady stream of what appears to be foam. A foaming condition can lead to faulty operation of the level sensors in the separator tank and also water carryover into the discharge piping. If foaming is encountered the potable water should be drained using the FILTER DRAIN and SEPARATOR DRAIN manual valves. Remove water filter vent plug (12, Figure 6-17) and add approximately three (3) tablespoons or 1.5 ounces of antifoam agent through vent port. Replace vent plug and refill potable (IAW Table 2-2).

Table 2-5. Battle Override Operation Procedures (continued)

Step	Action	Indication
4. (cont.)	a) If water drops to low- level (3/8 full in sight glass) stop LPAC and open SEPARATOR FILL valve (12, Figure 2-2). Close valve when water reaches normal level (5/8 full in sight glass).	Water level in water level sight glass (16, Figure 2-2) rises.
	b) If water rises to high level (7/8 full in sight glass) open SEPARATOR DRAIN valve (15, Figure 2-2). Close valve when water reaches normal level (5/8 full in sight glass).	Water level in water level sight glass (16, Figure 2-2) drops.
5.		***CAUTION*** Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.
	On completion of battle override operations set ON/OFF selector switch (5, Figure 2-1) to OFF.	PLC touchscreen display (3, Figure 2-1) blanks.

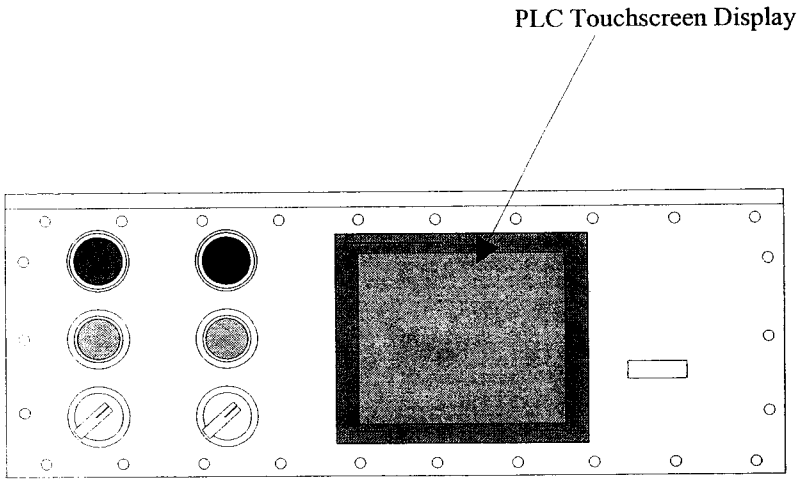


Figure Number	Description
2-4.1	MAIN Screen
2-4.2	RUN Screen
2-4.3	LOG DATA Screen
2-4.4	SHIPS AIR Screen
2-4.5	SEPARATOR TANK STATUS Screen
2-4.6	ALARM HISTORY Screen 1
2-4.7	ALARM HISTORY Screen 2
2-4.8	MAIN MAINTENANCE Screen 1
2-4.9	MAINTENANCE Screen 2
2-4.10	MAINTENANCE Screen 3
2-4.11	MAINTENANCE Screen 4
2-4.12	MAINTENANCE Screen 5
2-4.13	MAINTENANCE Screen 6
2-4.14	MAINTENANCE Screen 7
2-4.15	MAINTENANCE Screen 8
2-4.16	TRENDING DATA Screen
2-4.17	PROGRAM Screen 1
2-4.18	PROGRAM CURSOR Screen
2-4.19	PROGRAM Screen 2
2-4.20	PROGRAM Screen 3
2-4.21	PROGRAM Screen 4
2-4.22	PROGRAM Screen 5
2-4.23	PROGRAM Screen 6
2-4.24	PROGRAM Screen 7
2-4.25	PROGRAM Screen 8

Figure 2-4. PLC Screen Displays

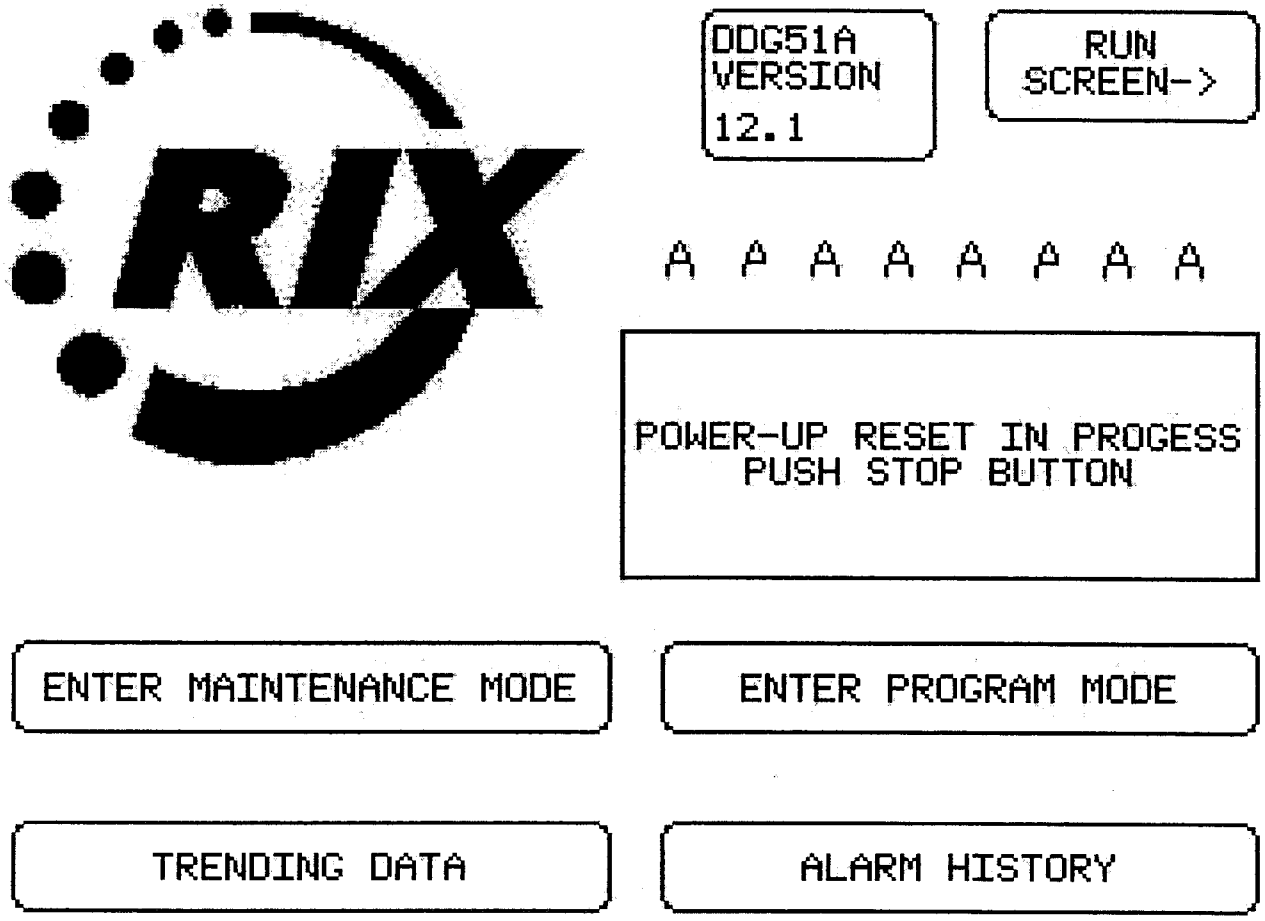


Figure 2-4.1. Main Screen

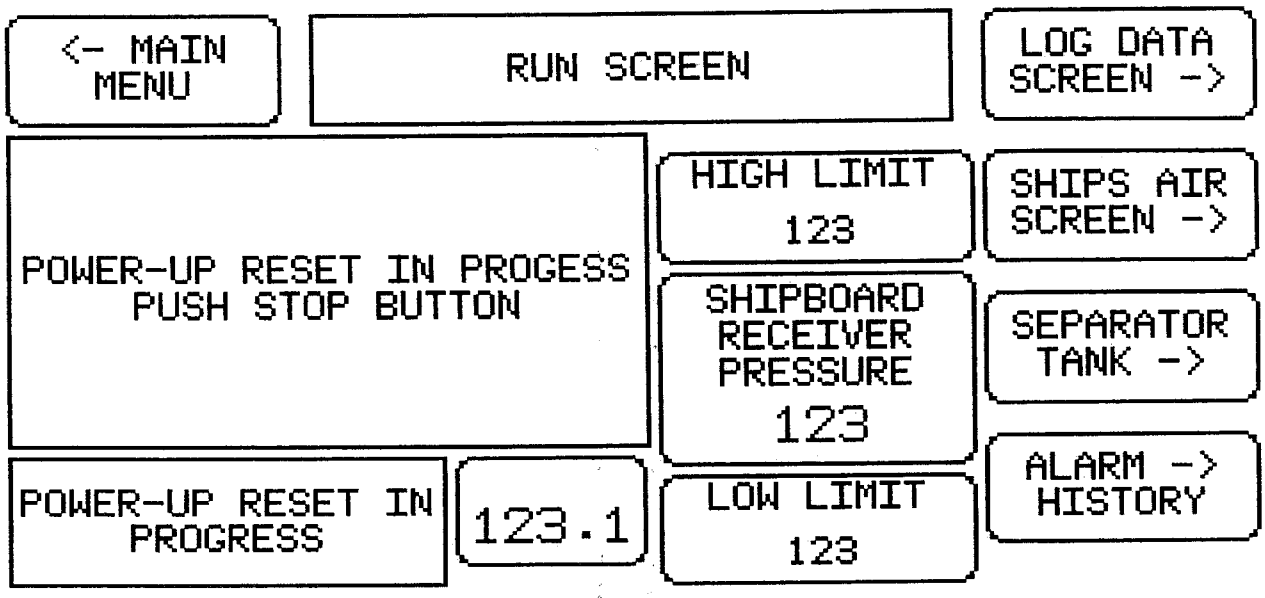


Figure 2-4.2. Run Screen

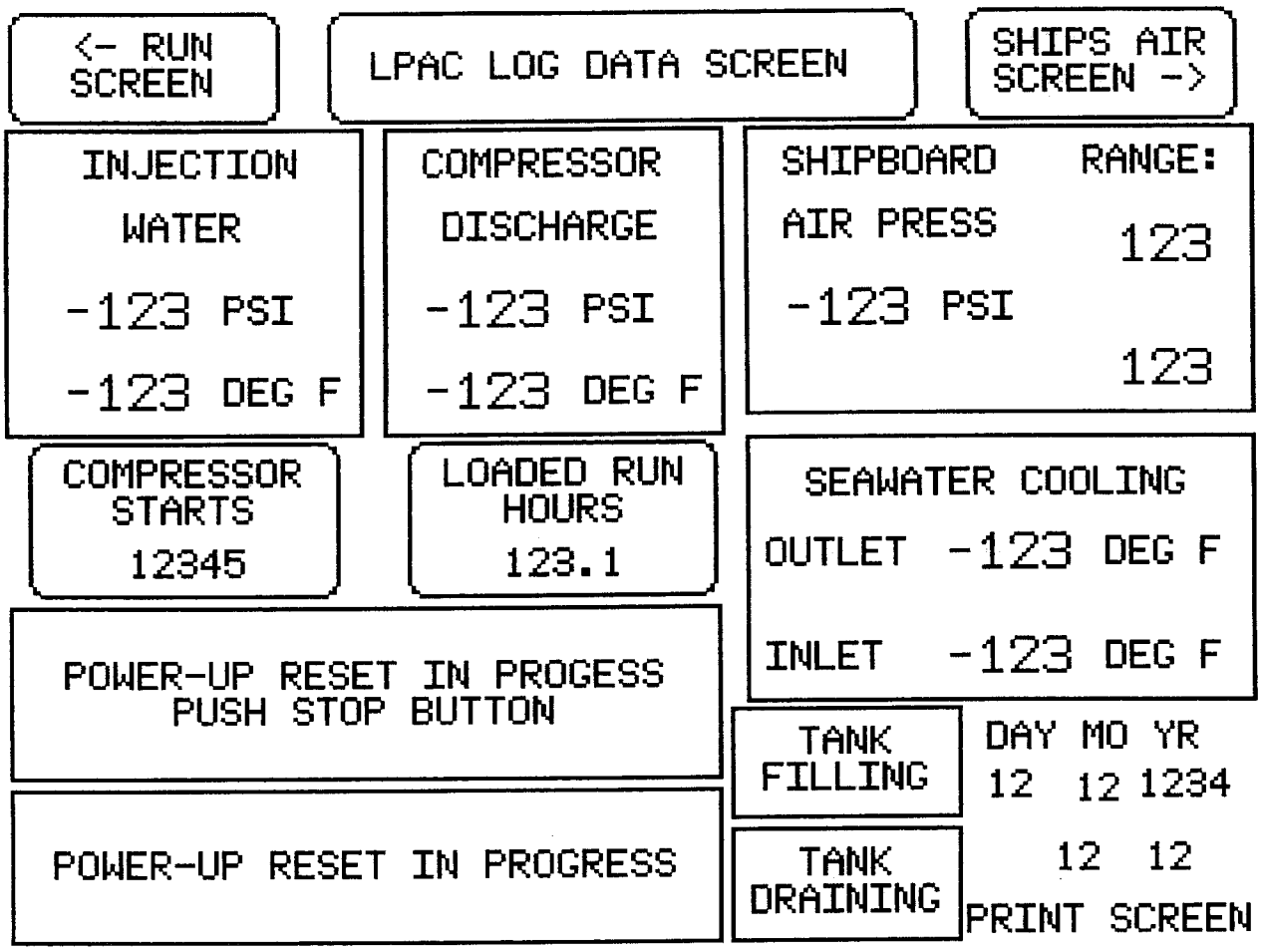


Figure 2-4.3. Log Data Screen

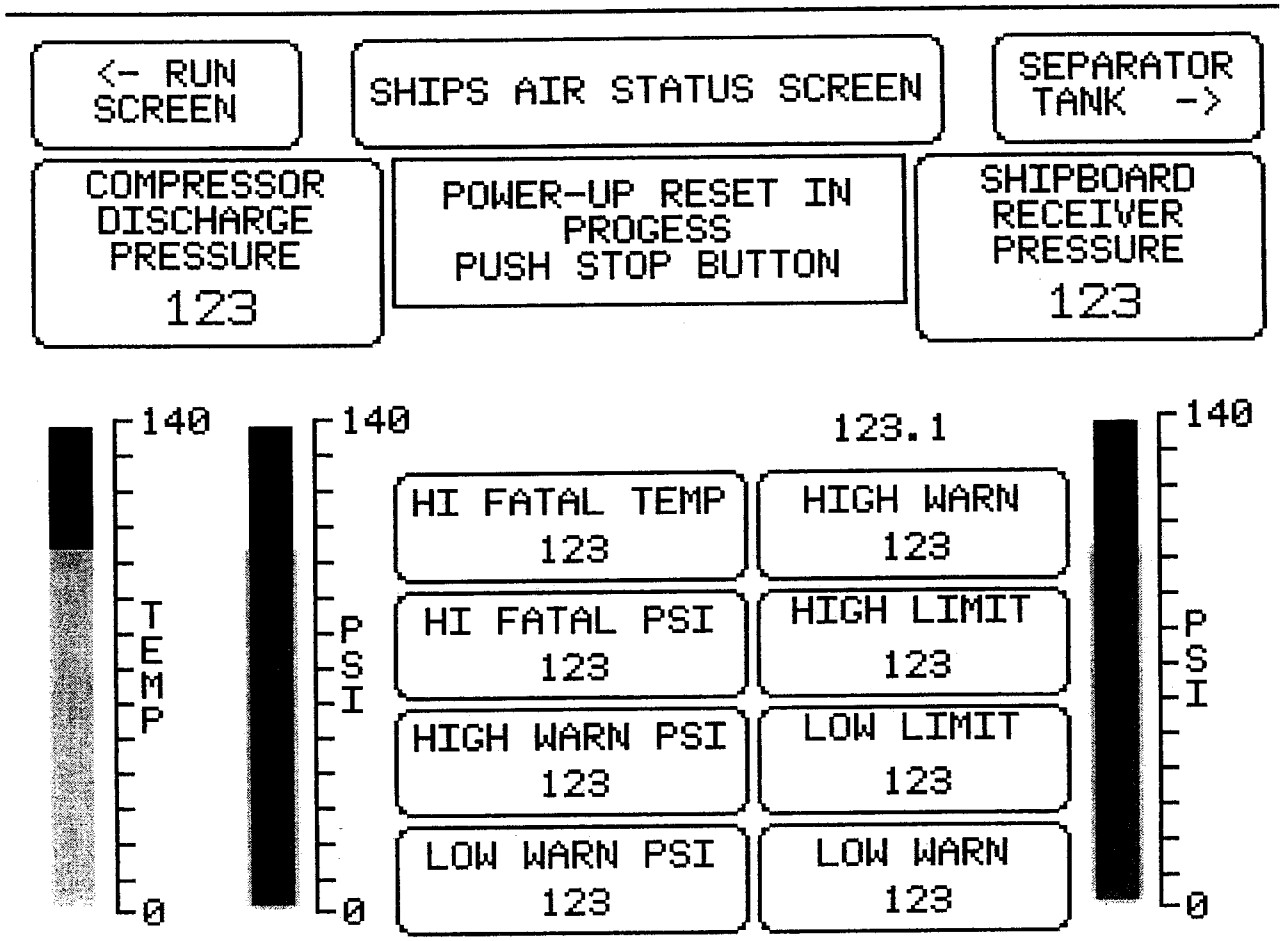


Figure 2-4.4. Ship's Air Status Screen

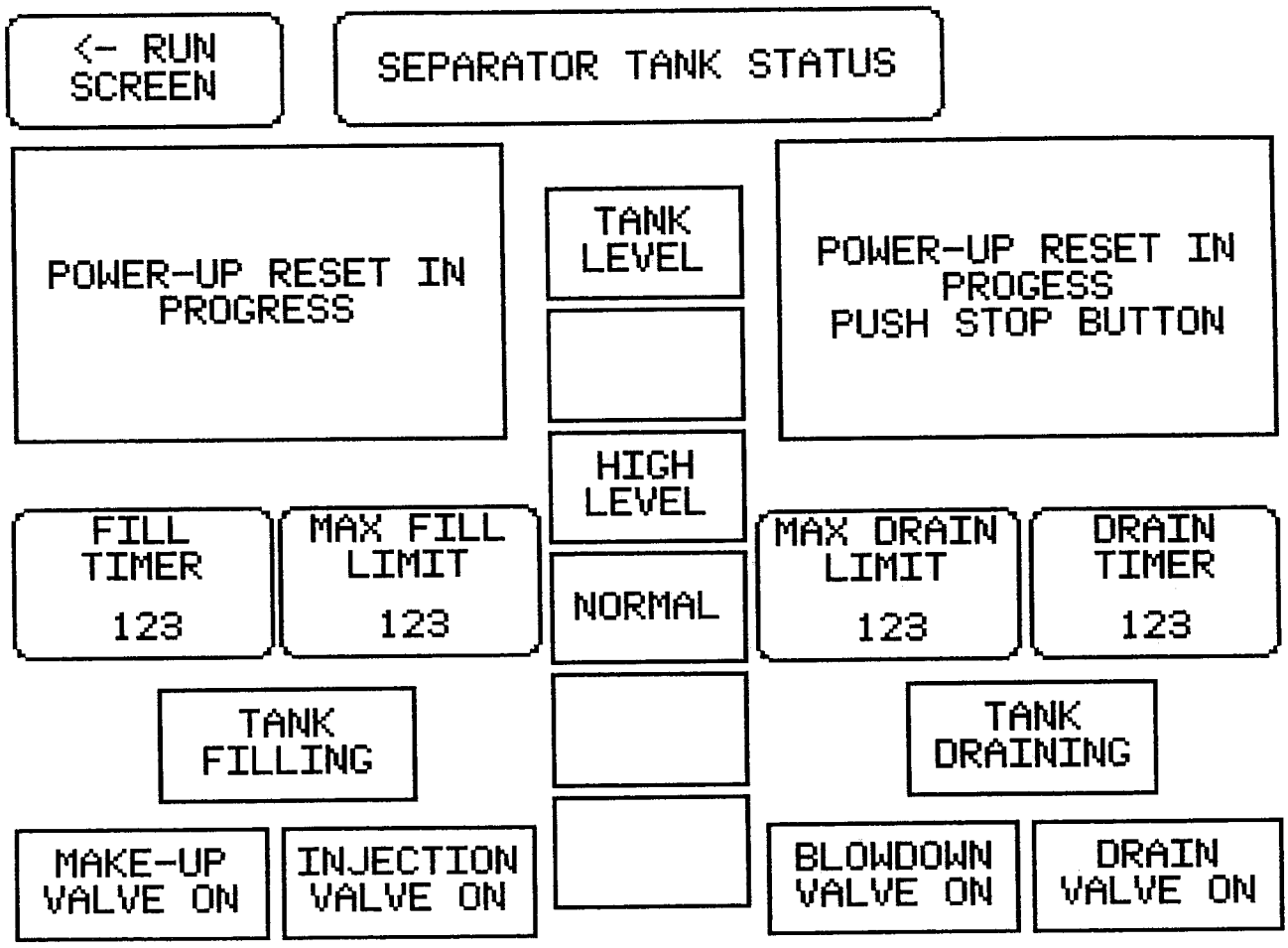


Figure 2-4.5. Separator Tank Screen

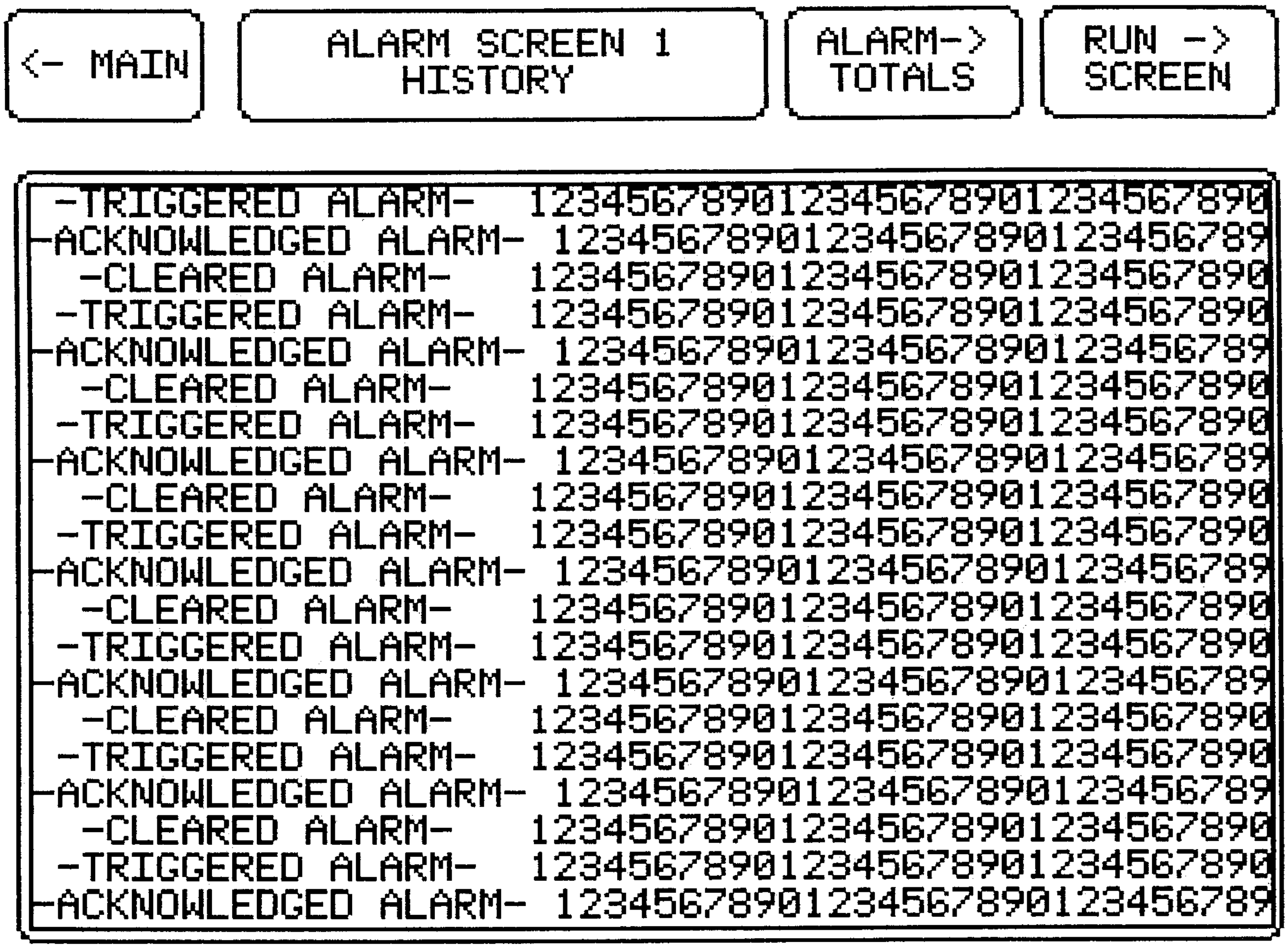


Figure 2-4.6. Alarm History Screen 1

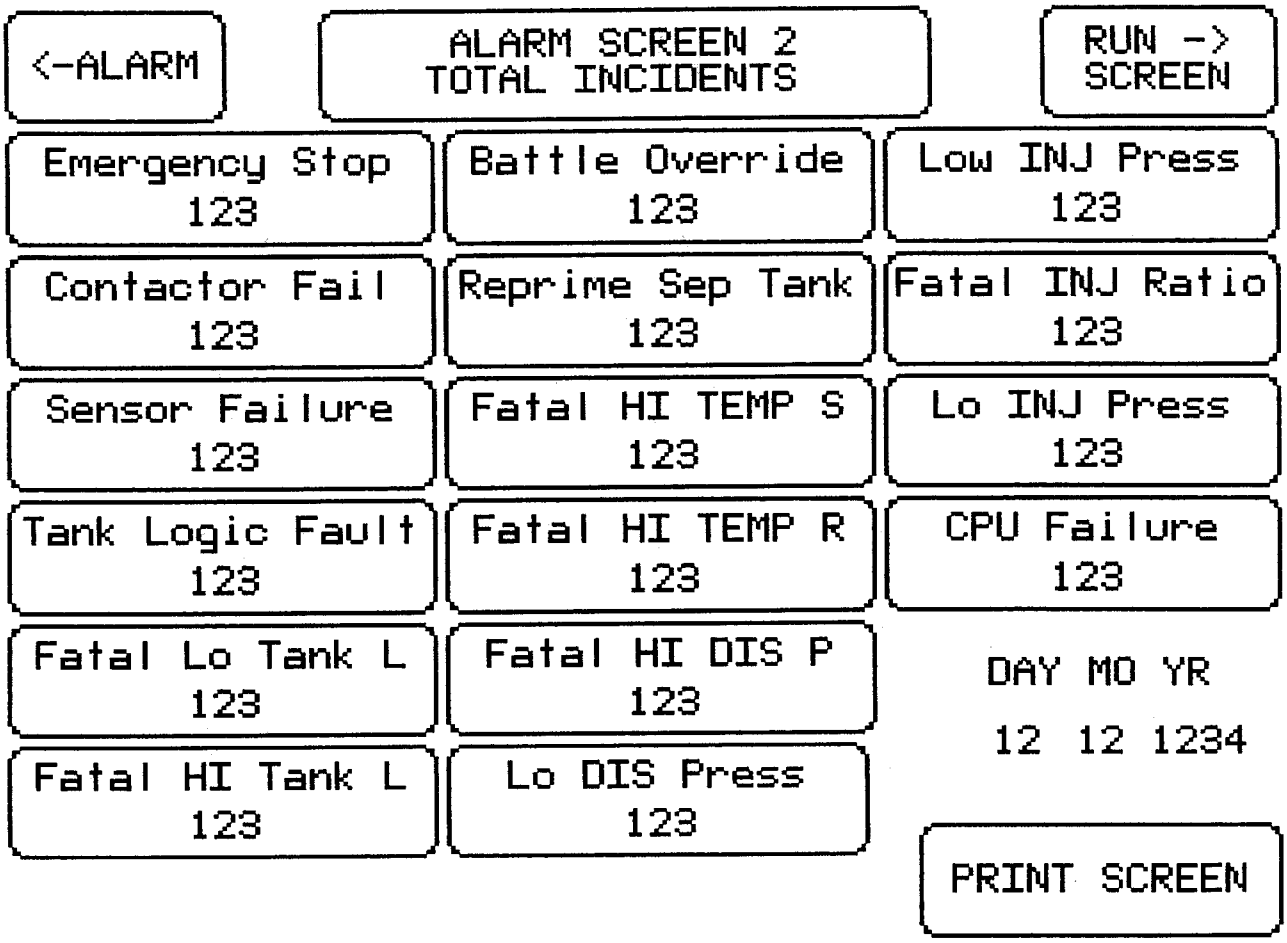


Figure 2-4.7. Alarm History Screen 2

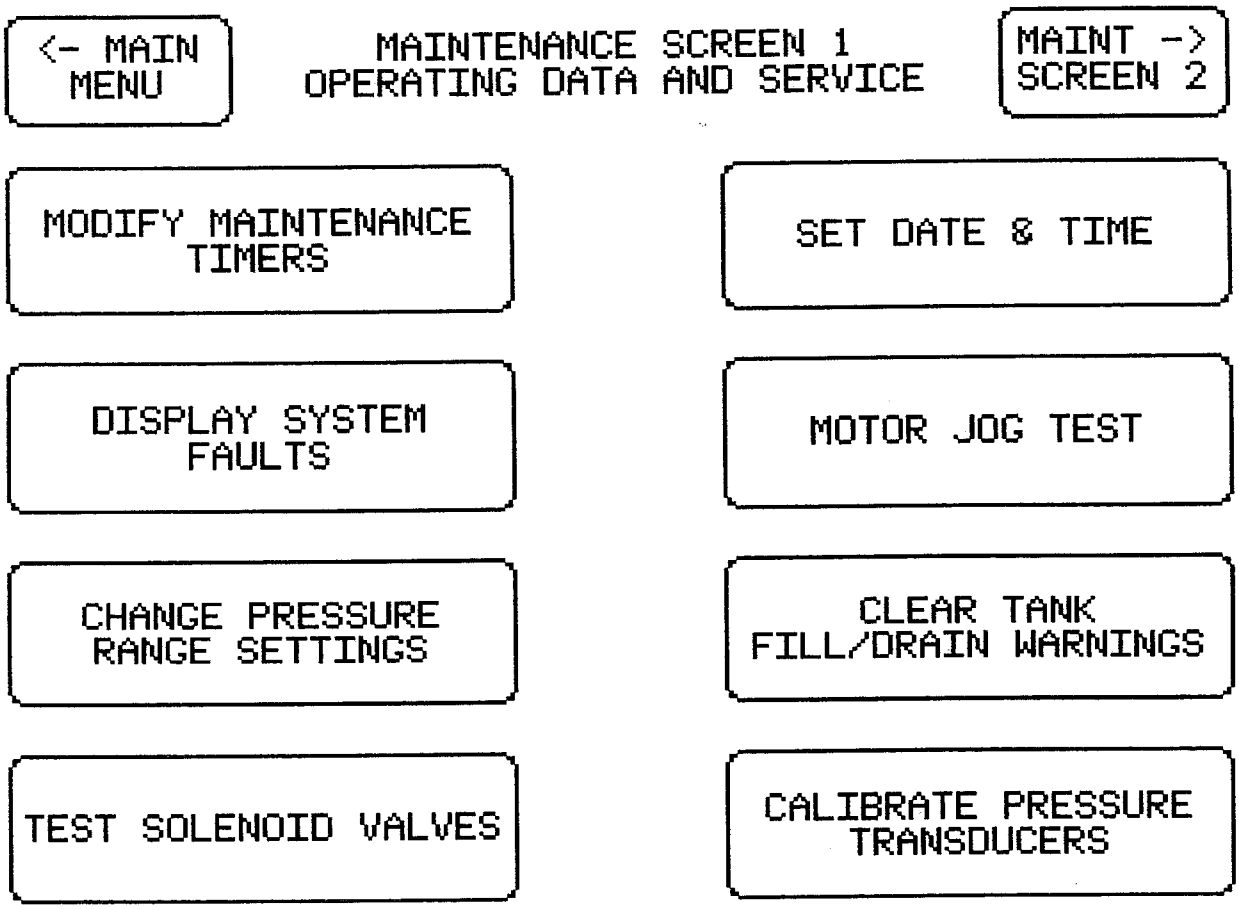


Figure 2-4.8. Maintenance Mode Screen 1

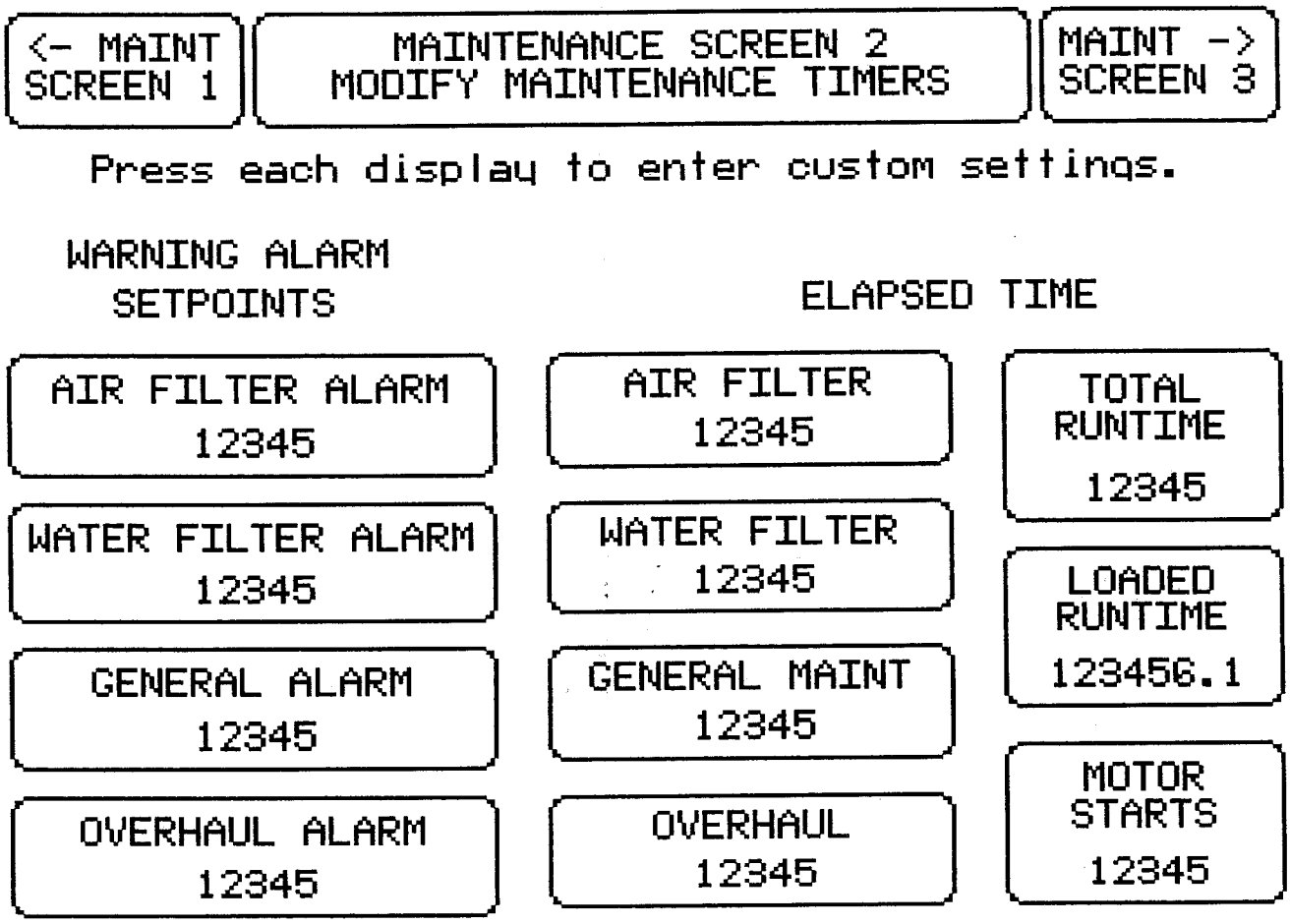


Figure 2-4.9. Maintenance Mode Screen 2

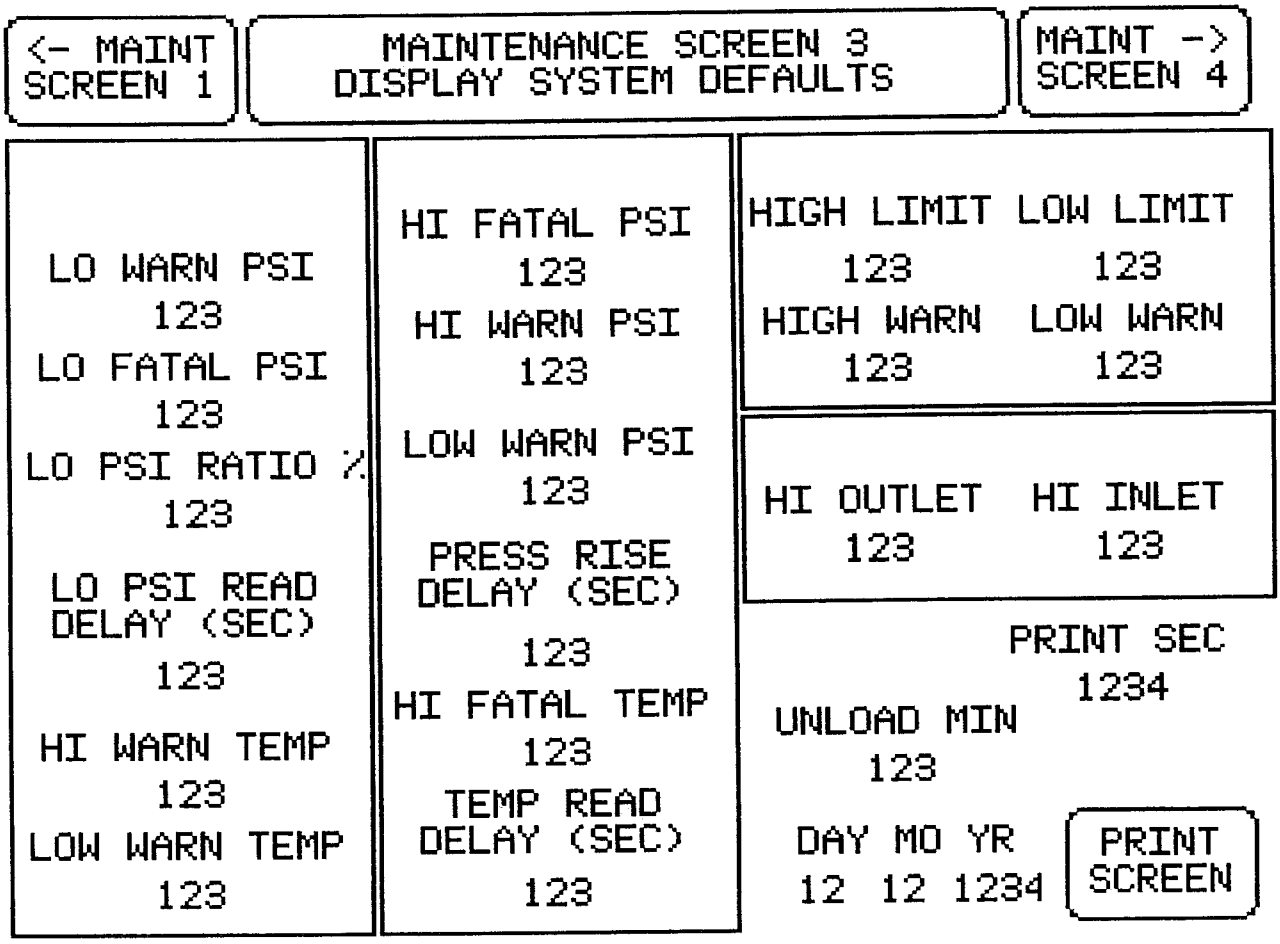


Figure 2-4.10. Maintenance Mode Screen 3

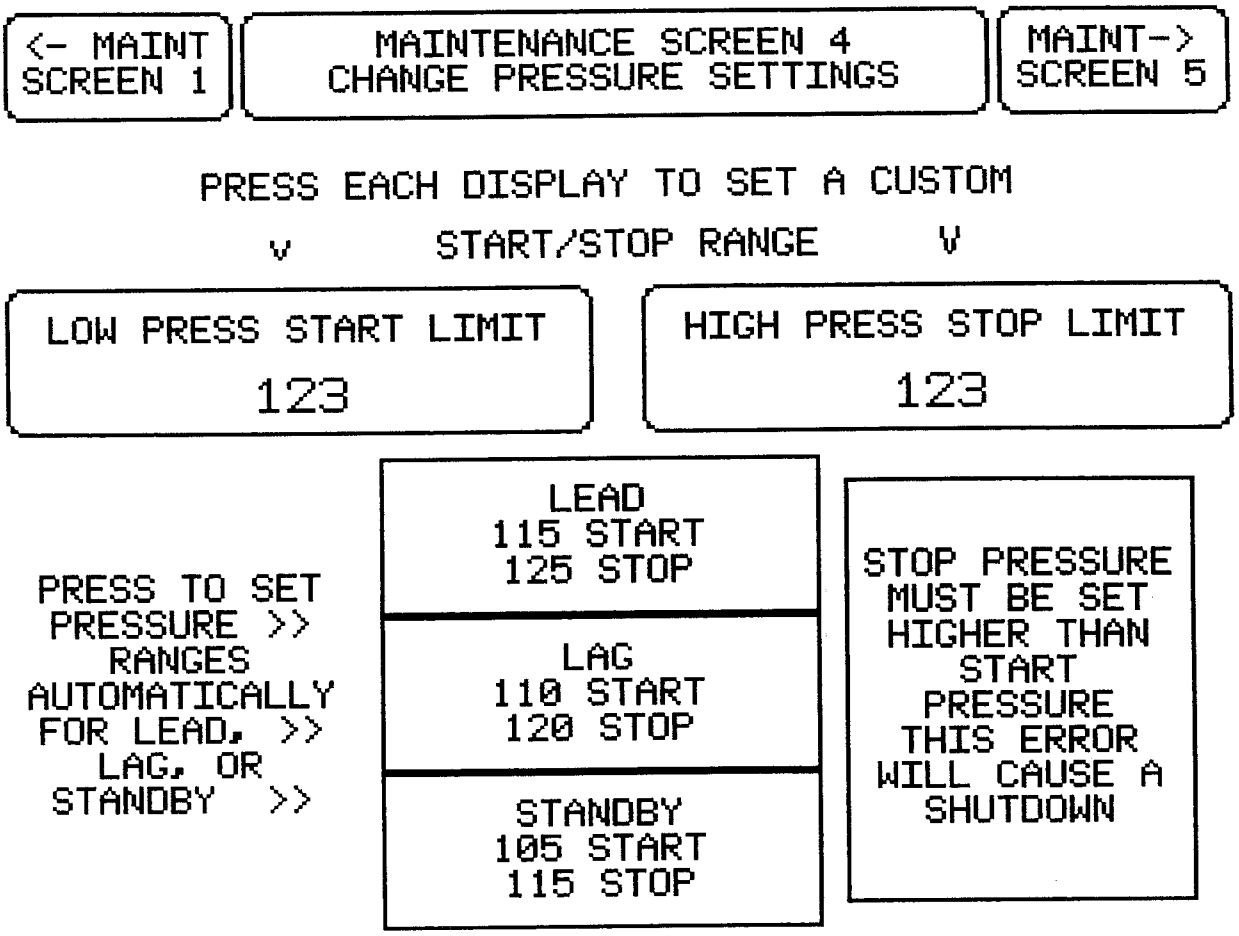


Figure 2-4.11. Maintenance Mode Screen 4

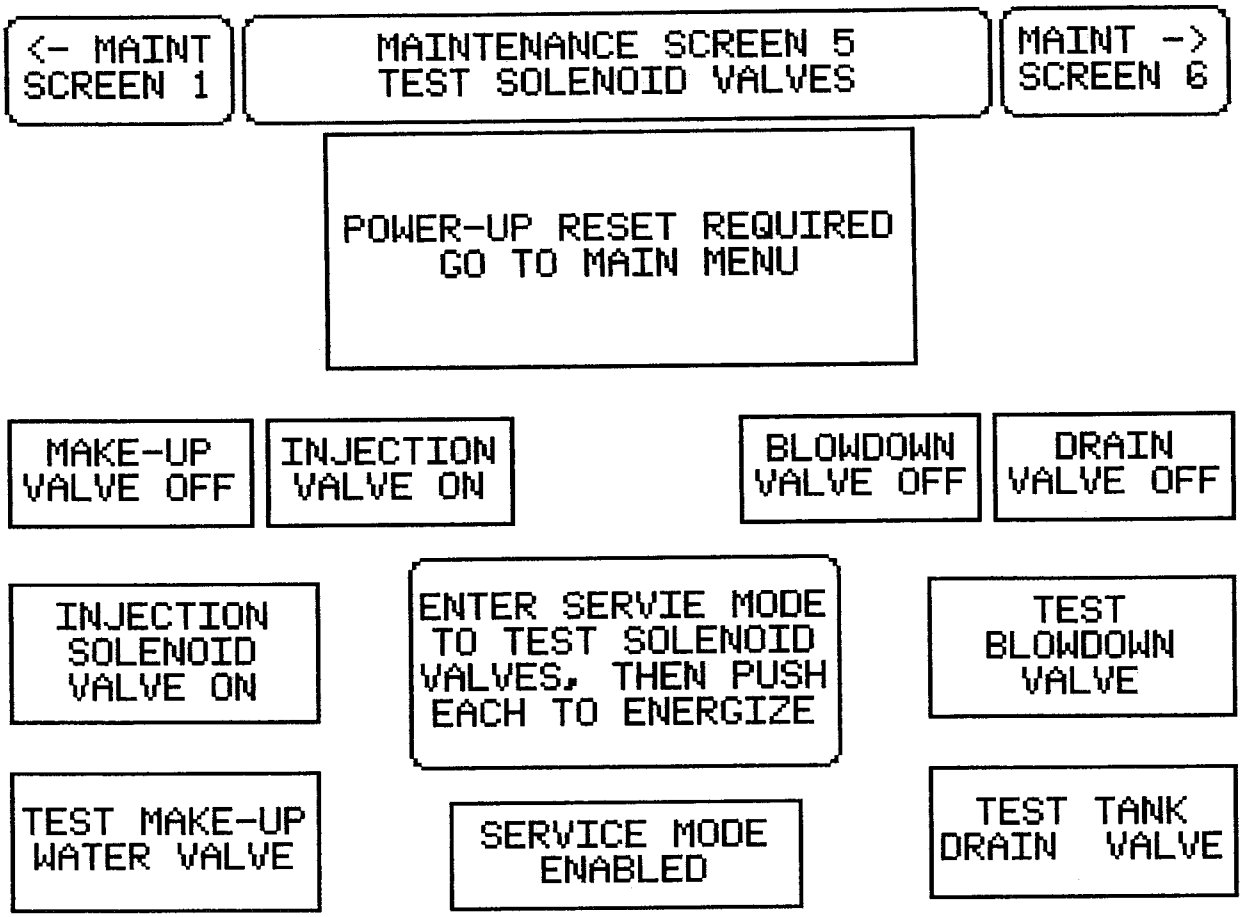


Figure 2-4.12. Maintenance Mode Screen 5

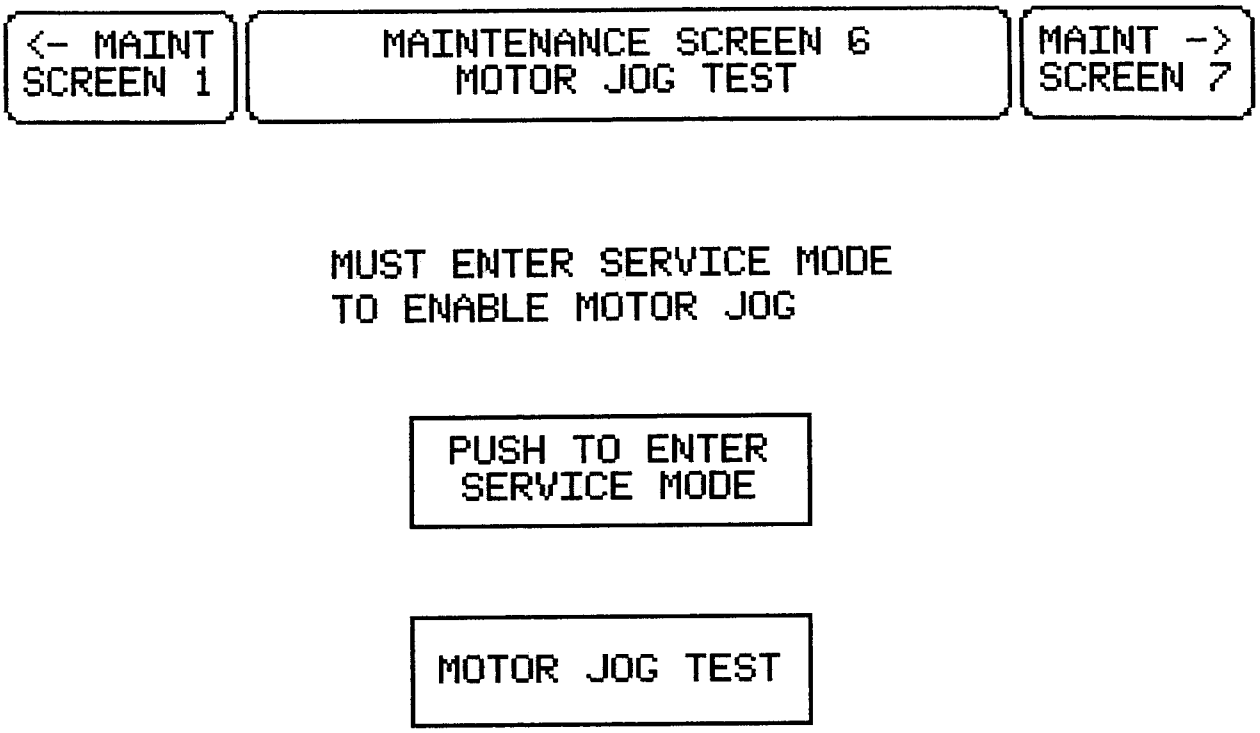


Figure 2-4.13. Maintenance Mode Screen 6

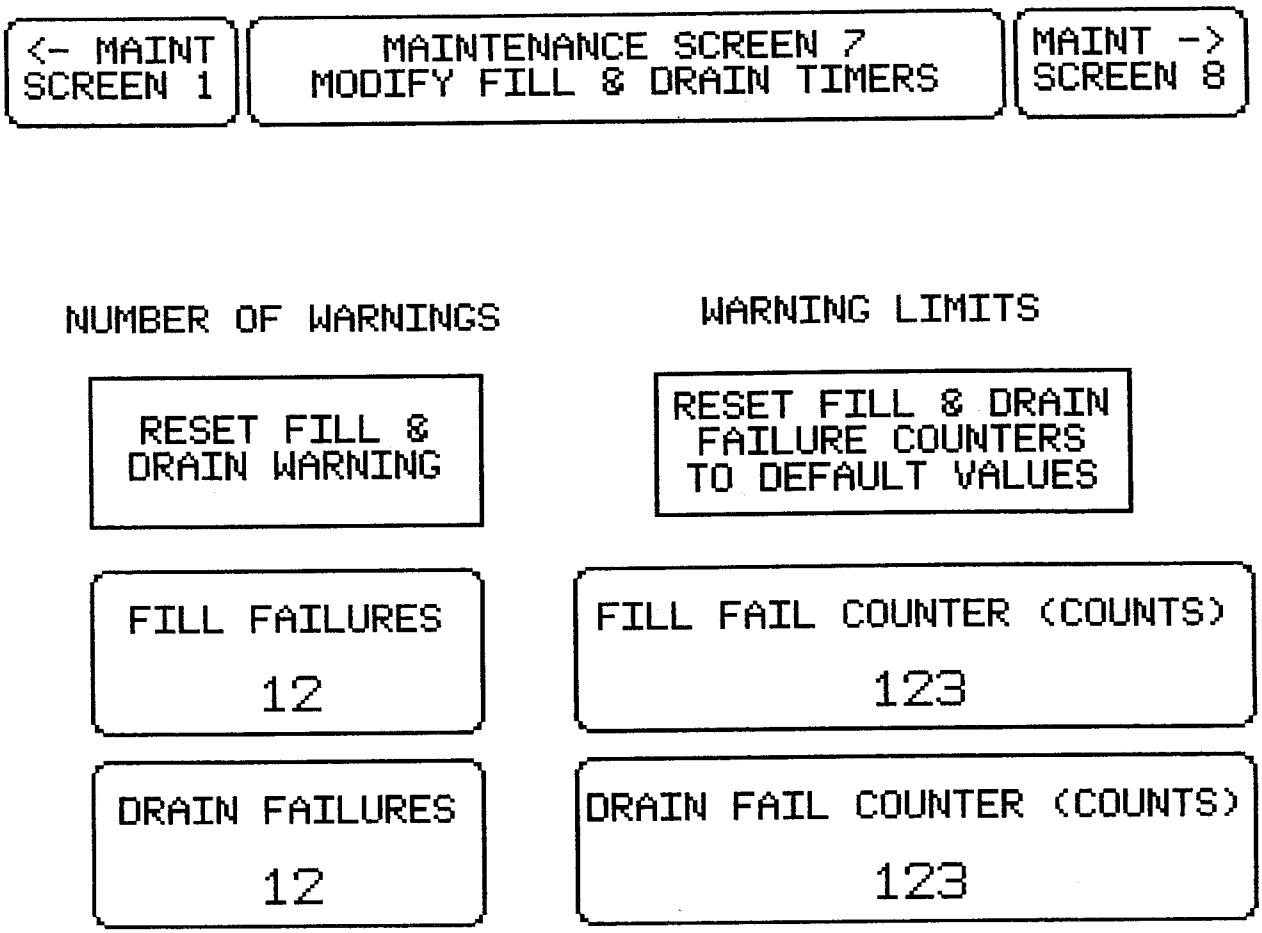


Figure 2-4.14. Maintenance Mode Screen 7

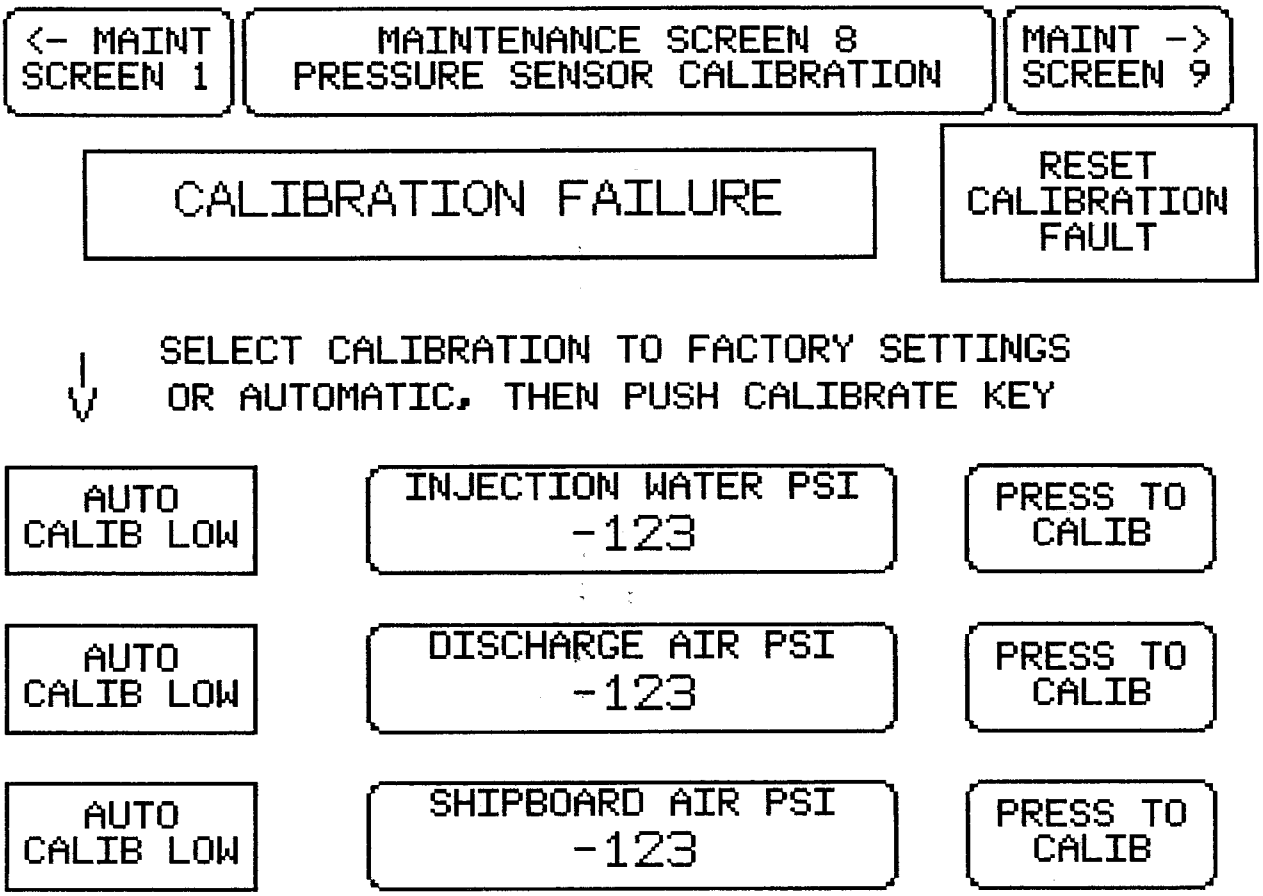


Figure 2-4.15. Maintenance Mode Screen 8

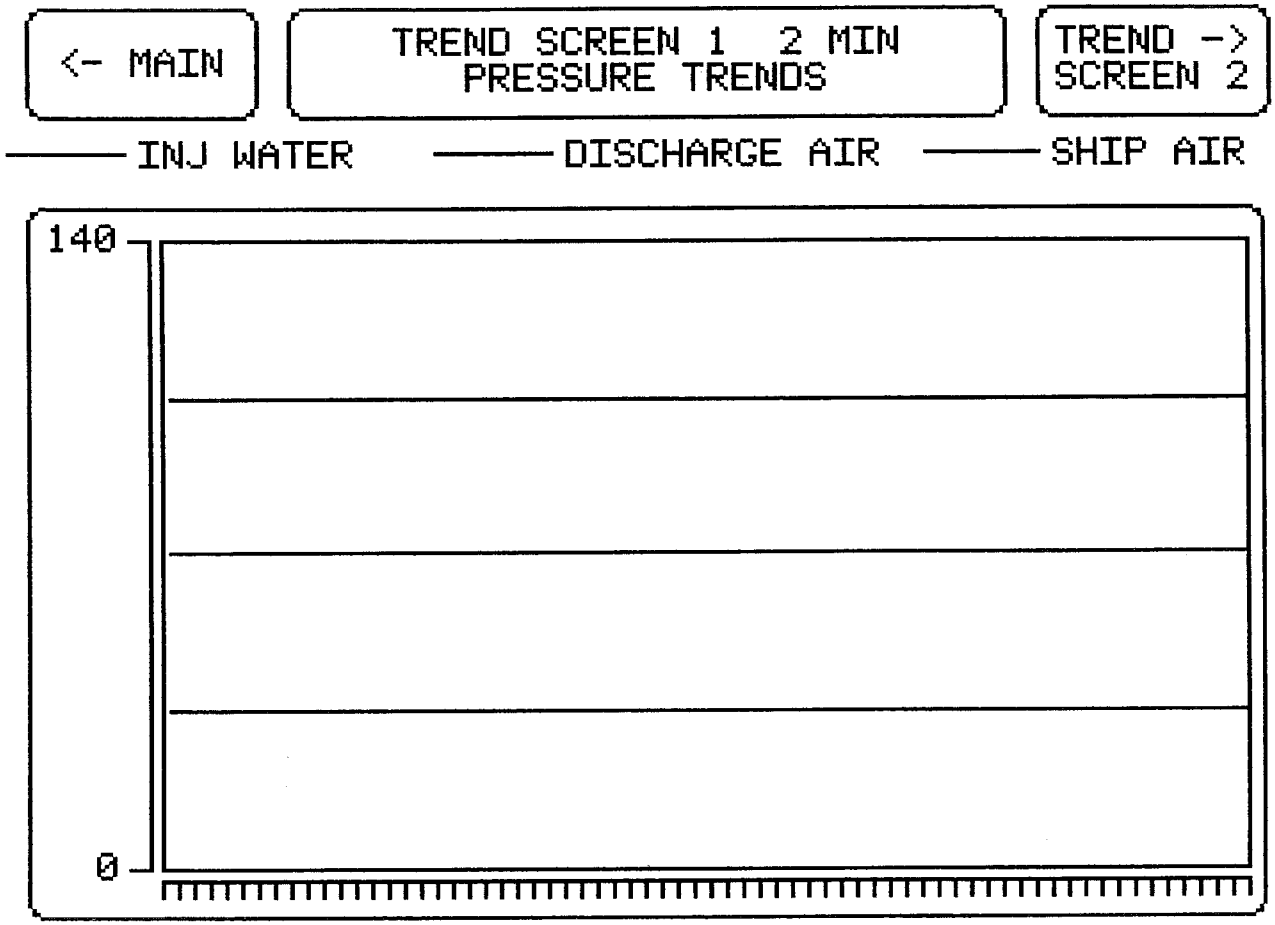


Figure 2-4.16. Trending Data Screen

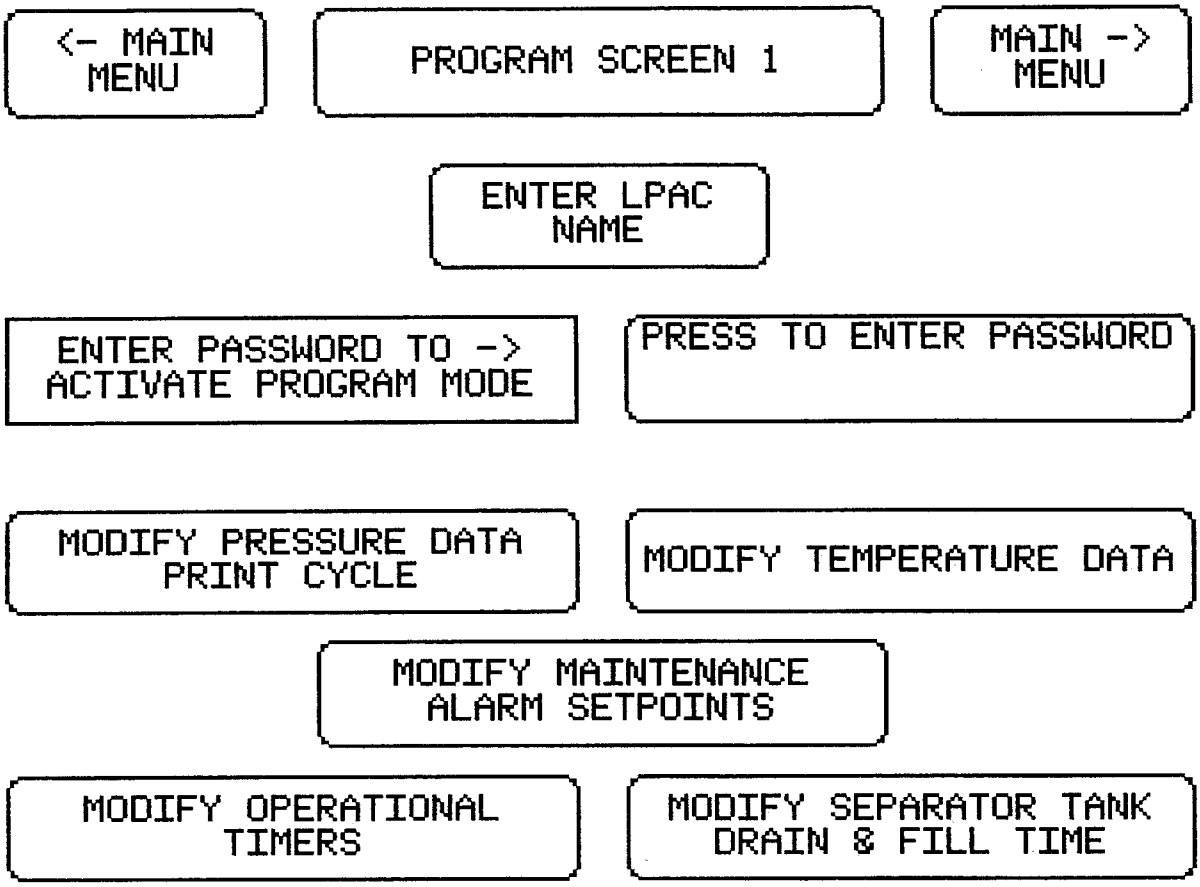


Figure 2-4.17. Program Mode Screen 1

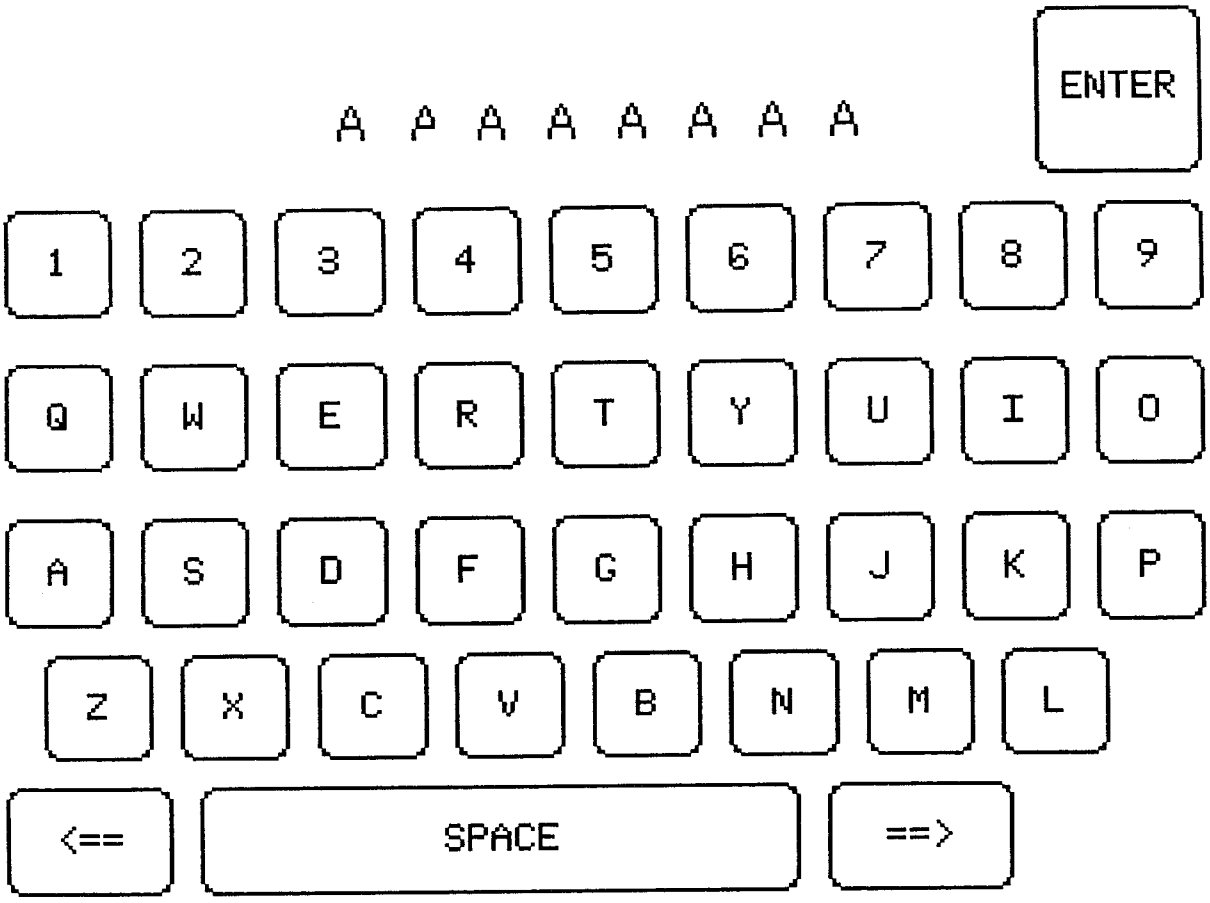


Figure 2-4.18. Program Mode Screen

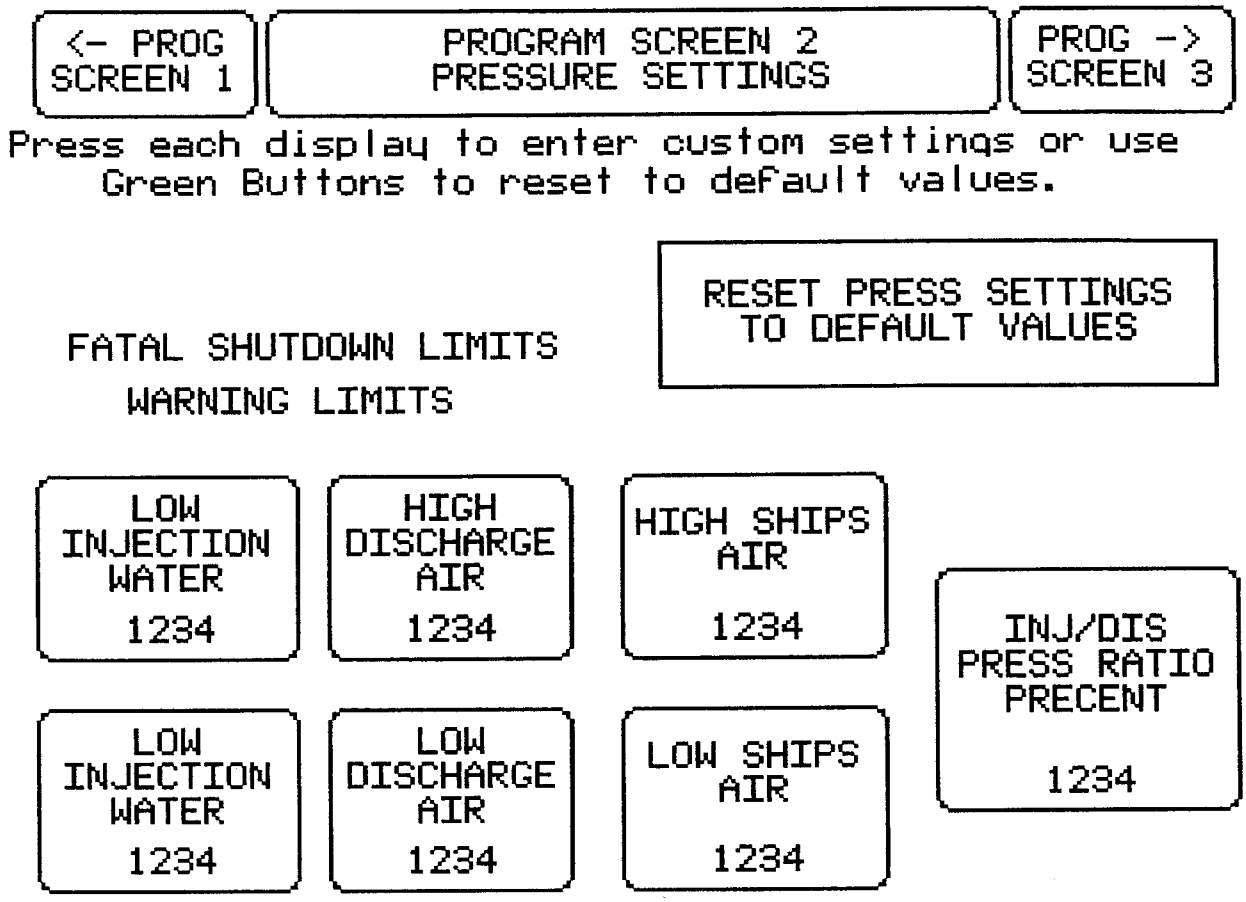


Figure 2-4.19. Program Mode Screen 2

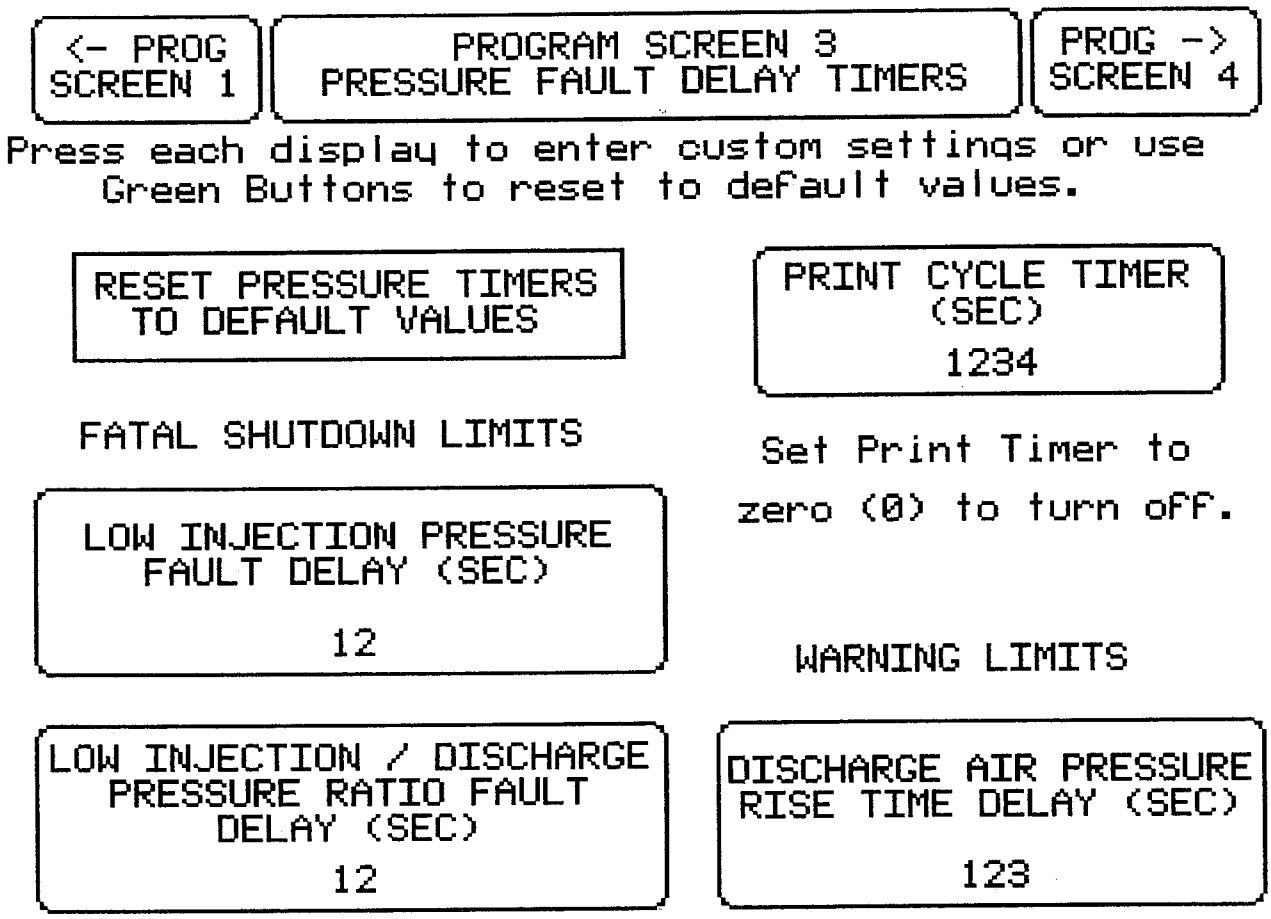


Figure 2-4.20. Program Mode Screen 3

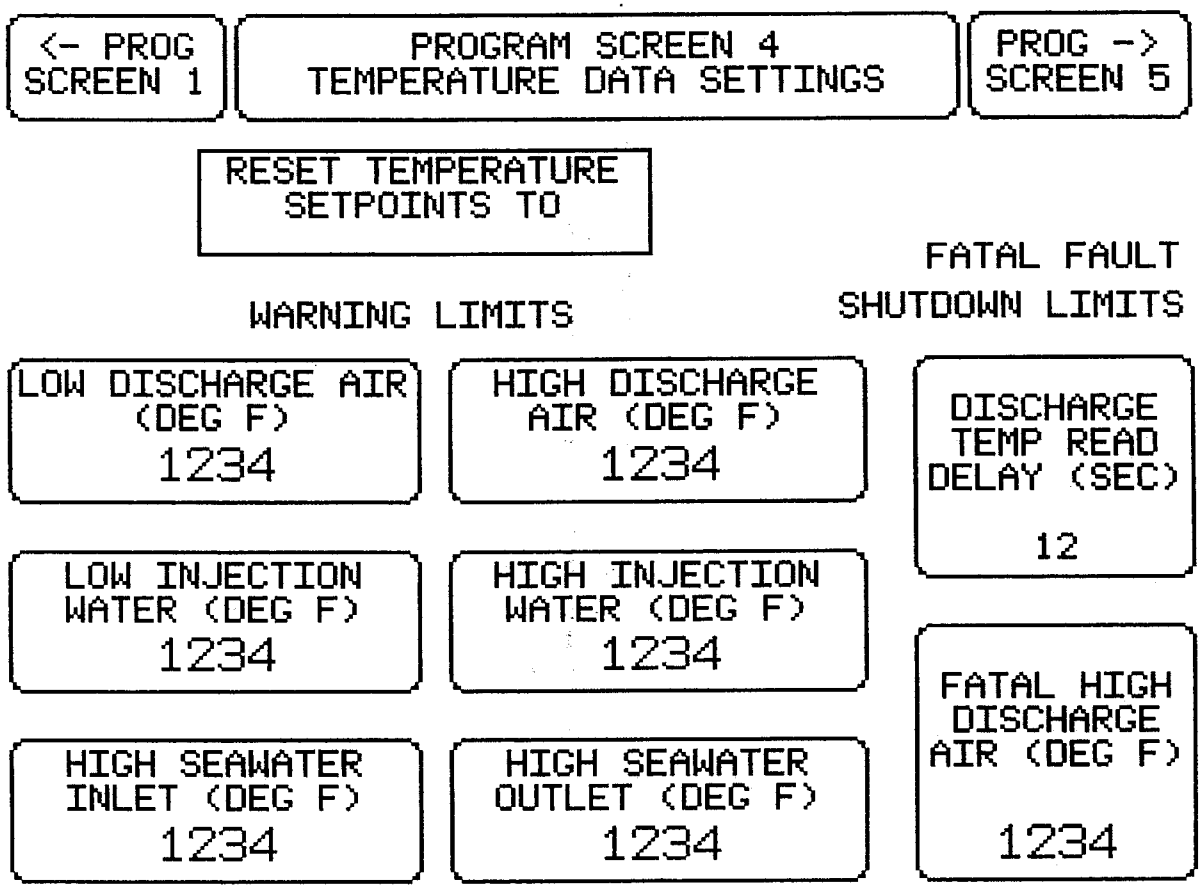


Figure 2-4.21. Program Mode Screen 4

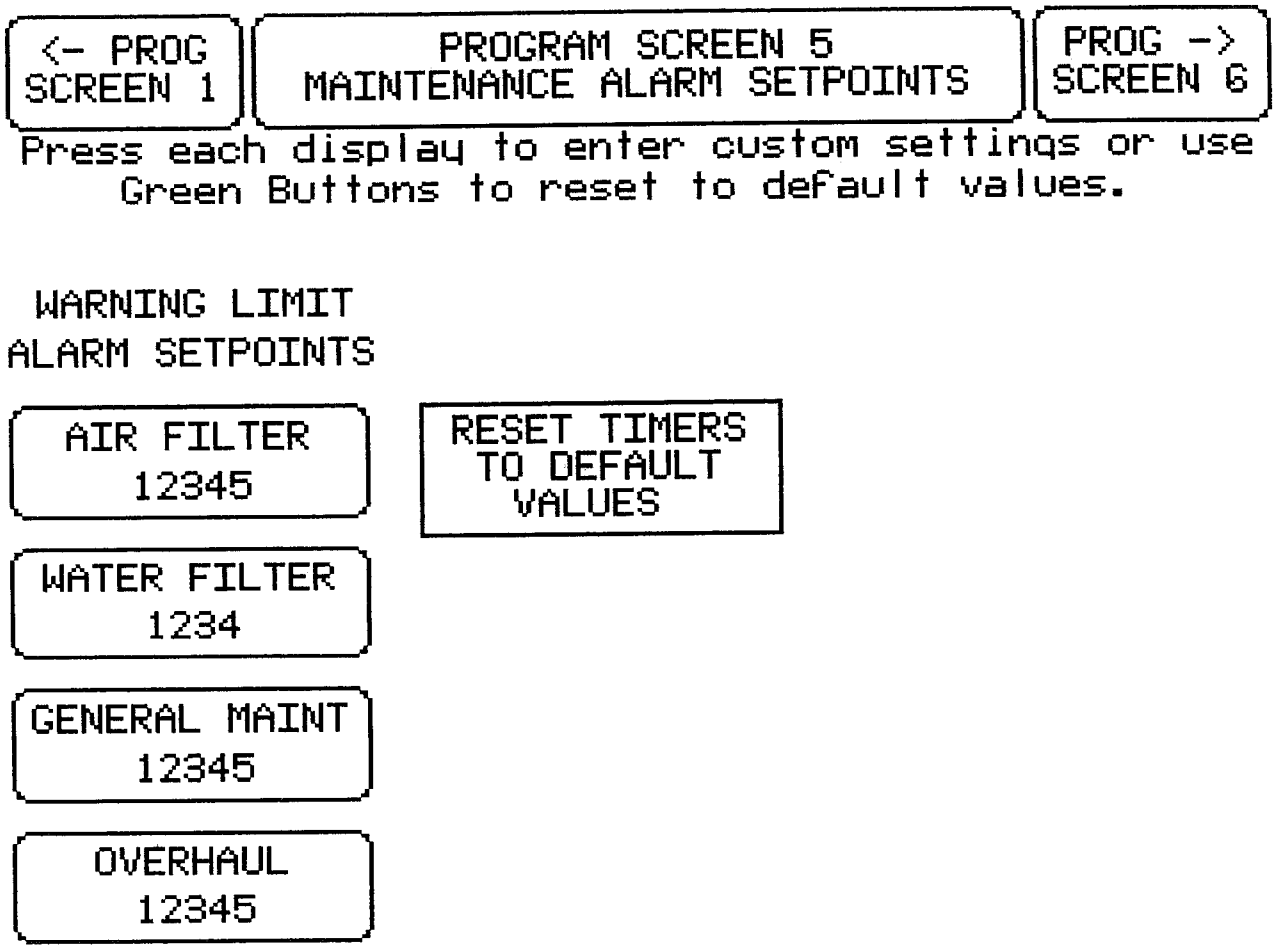


Figure 2-4.22. Program Mode Screen 5

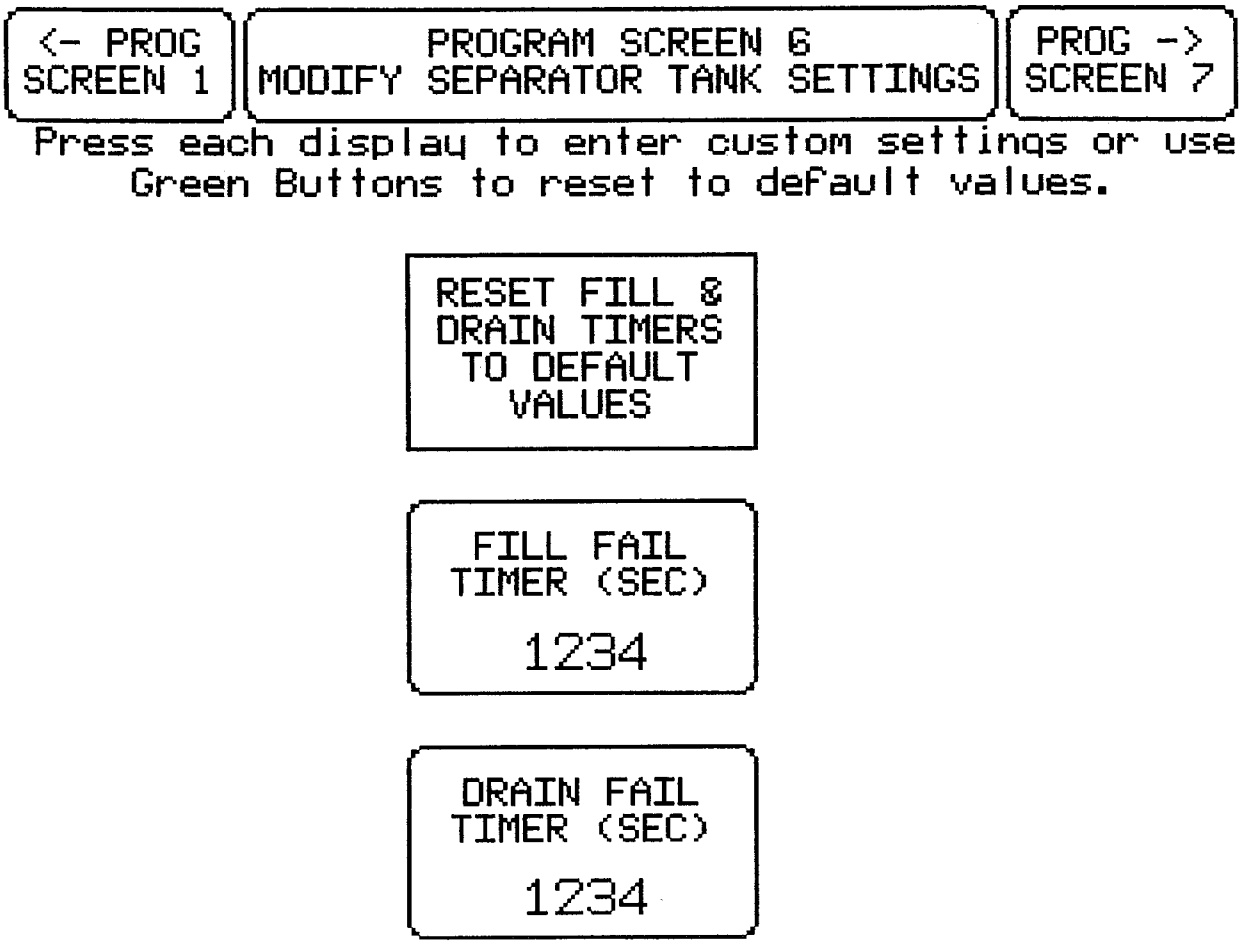


Figure 2-4.23. Program Mode Screen 6

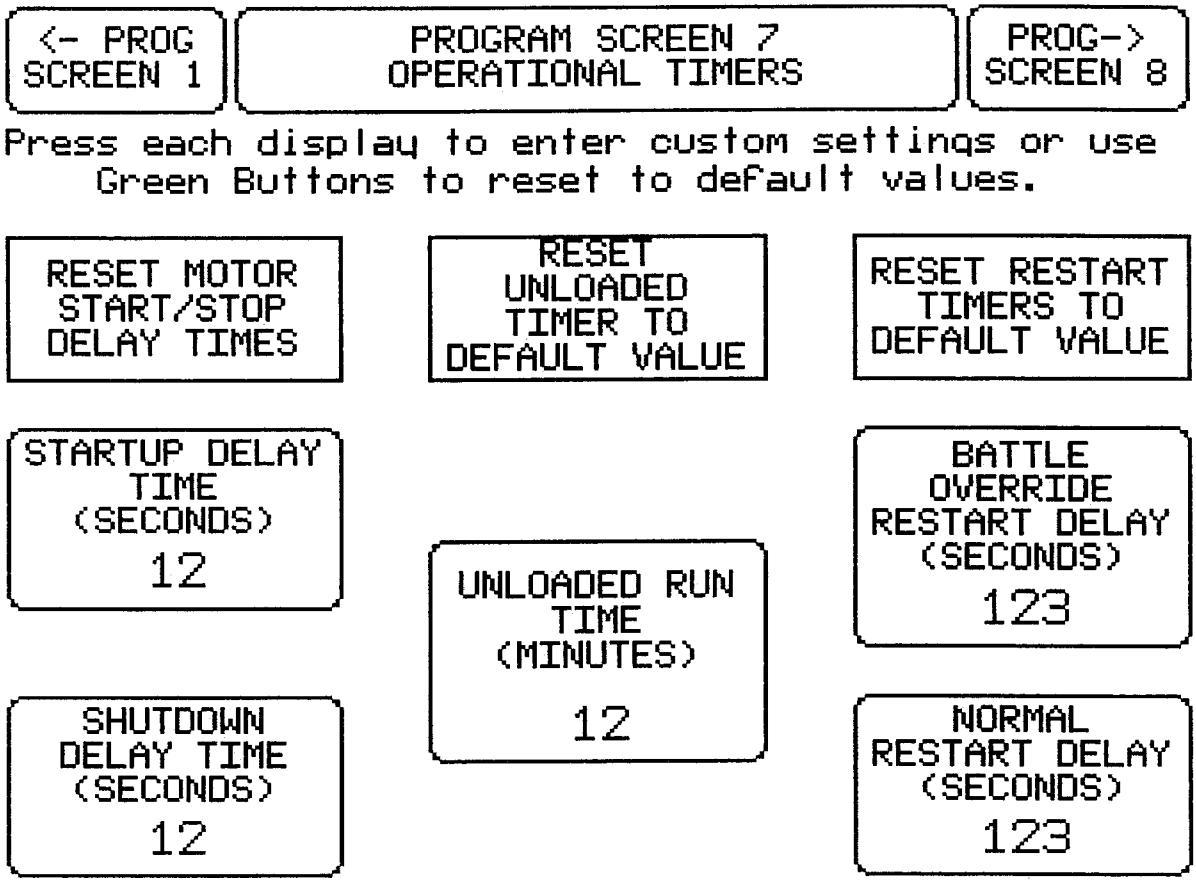


Figure 2-4.24. Program Mode Screen 7

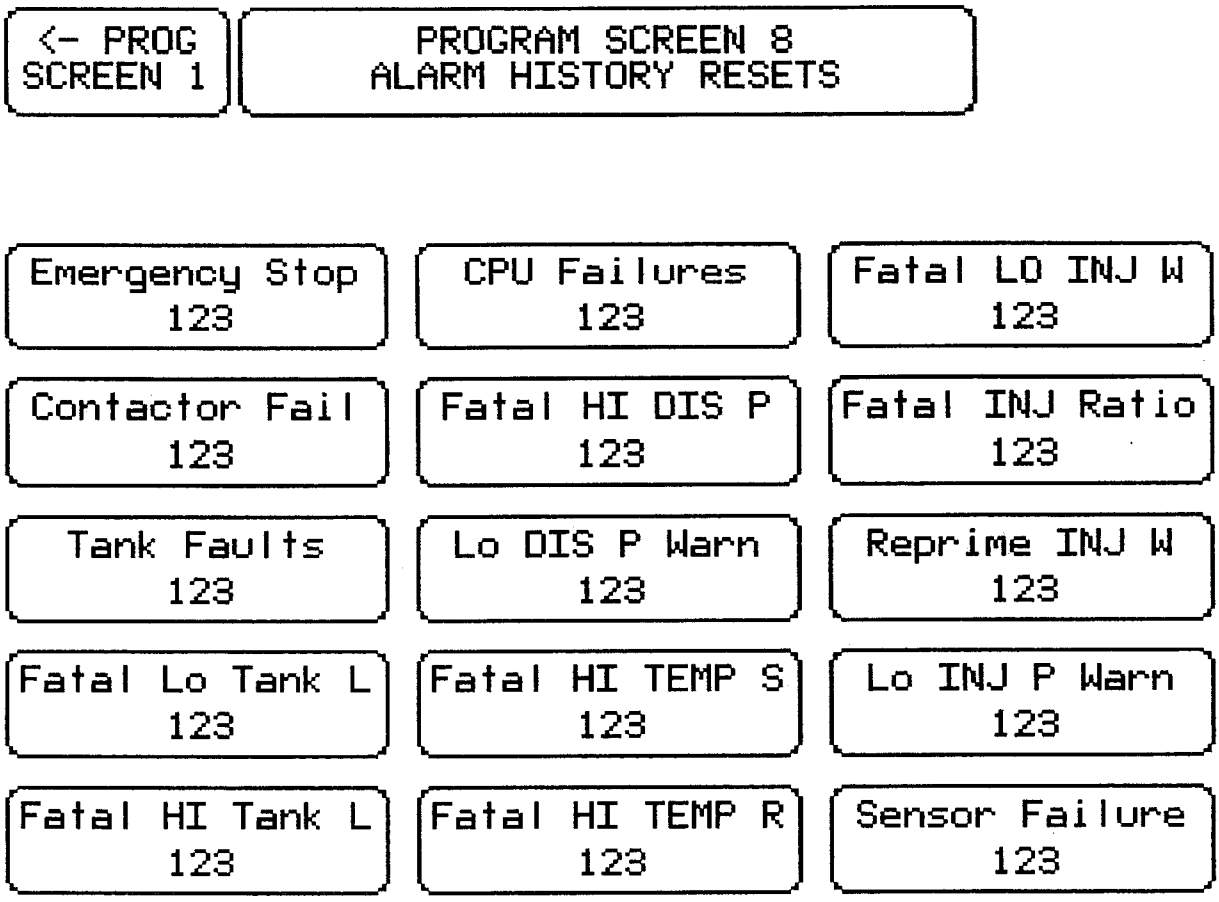


Figure 2-4.25. Program Mode Screen 8

CHAPTER 3
FUNCTIONAL DESCRIPTION

3-1. INTRODUCTION.

Chapter 3 provides functional descriptions of the model STAR 200 low-pressure air compressor (LPAC) and its components. Chapter 3 also provides knowledge necessary for maintenance personnel to isolate LPAC malfunctions, and aid in understanding troubleshooting procedures found in Chapter 5.

3-2. AIR COMPRESSOR UNIT.

3-2.1 Description. The rotary, single-screw, water-flooded LPAC is a constant speed, single stage packaged unit mounted on a common welded steel base. The LPAC is designed to provide 200 standard cubic feet-per-minute (scfm) of oil-free air compressed to a maximum of 125 pounds-per-square-inch gauge (psig). Although capable of manual control, the LPAC is designed for fully automatic operation and a minimum of operator attendance. During normal operation of the LPAC, "No Leakage" should be observed from the distance piece external drain. A small amount of leakage during start up or shut down of the LPAC at the distance piece external drain is allowable and acceptable. Leakage at the external drain during normal operation is an indication of main rotor labyrinth wear and probable reduced capacity of the LPAC. Operation of the LPAC with leakage from the distance piece external drain is acceptable, however, the LPAC must be scheduled for an overhaul at the next availability.

3-2.2 Output Pressures. One of three default pressure ranges: 105 - 115, 110 - 120, or 115 - 125 is selected by the operator on the programmable logic controller (PLC) touchscreen display (3, Figure 2-1). Custom pressure ranges up to the maximum value of 125 psig can also be field programmed into the PLC. Paragraph 2-5 explains the procedures for field programming the PLC.

3-2.3 Operating Cycle. In automatic operation, when the shipboard system pressure drops to the default low-pressure setting, the compressor management system (CMS) starts the drive motor. The motor drives the compressor assembly's main rotor at approximately 3,565 revolutions-per-minute (RPM). Potable (fresh) water is injected into the compressor assembly's suction end to cool the rotors, seal the air in the main rotor grooves, and cool the compressed air. Within the compressor assembly the single, shaft-mounted, main rotor engages two planar gate rotors. The meshed rotor gear teeth compress the air/injection water mixture trapped in the main rotor grooves (refer to Figure 3-1). The compressed air/water mixture is then piped to the separator assembly where the moisture is separated-out and rerouted as injection water. The saturated air is routed to the ship's accumulator at 125 psig. When the shipboard system pressure rises to the default upper pressure setting, the CMS resets the LPAC to the unloaded mode. The LPAC operation is reduced to 50 psig and a metered orifice line is opened to maintain a constant 50-psig pressure within the compressor assembly. If no further ship system demand is made within the next 10 minutes (or the default time set on the unloader timer), the CMS stops the drive motor and bleeds the LPAC down to atmospheric pressure, shutting down the LPAC.

3-2.4 Control. During normal operation, the LPAC is controlled by the PLC microprocessor preset logic. An extensive array of temperature, pressure, and water level sensors monitor LPAC operation and provide inputs to the PLC. The operator may also use the PLC to manually control the LPAC operation.

3-3. COMPRESSOR SUBASSEMBLIES.

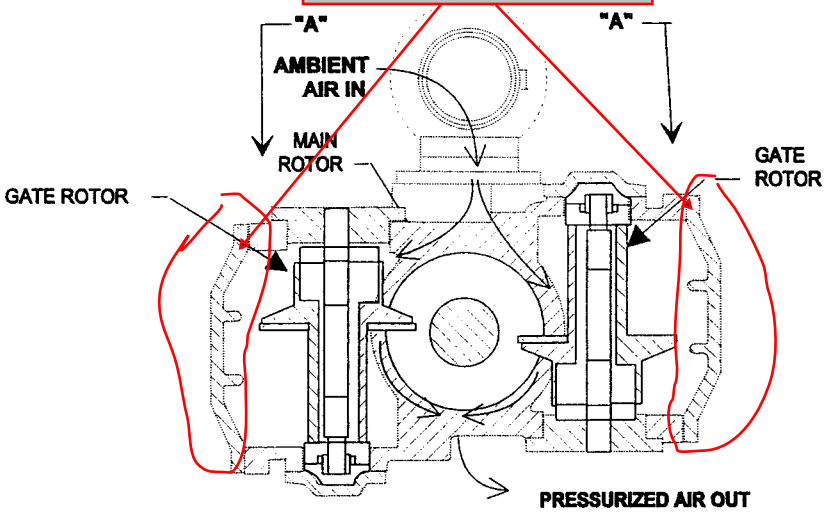
Functionally, the LPAC can be broken down into five major subassemblies. They are:

a) Drive Motor.
b) Air-End Components.
c) Closed Loop Potable Water System.
d) Seawater Cooling System.
e) CMS containing the PLC and HVE.

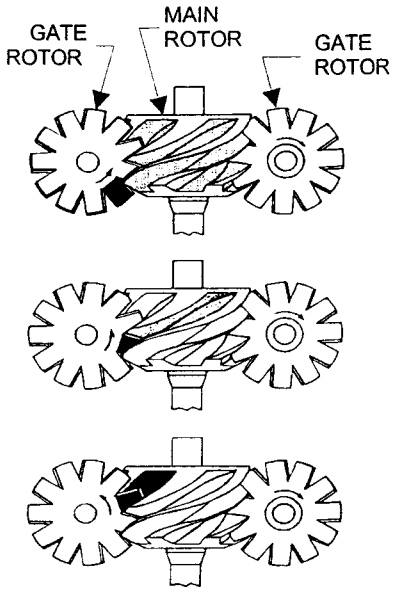
The functional relationship of these subassemblies is illustrated in Figure 3-2. Figures 3-3 and 3-4 illustrate the interaction of the LPAC components. The subassemblies are described in succeeding paragraphs.

3-3.1 Drive Motor. The 60 horsepower (hp), alternate current (ac) drive motor (refer to Figure 1-2) runs at a constant speed. A coupling, located inside the distance piece assembly (refer to Figure 1-2), directly couples the drive motor shaft to the compressor assembly's main rotor shaft. The drive motor is horizontally mounted behind the separator on a raised frame welded to the LPAC base.

Illustrate the sectional view of the compressor with flat



SECTIONAL VIEW OF COMPRESSOR ASSEMBLY



VIEW "A" - "A" AT THE BEGINNING OF COMPRESSION CYCLE GATE ROTOR TOOTH ABOUT TO ENTER FLUTE OF MAIN ROTOR.

VIEW "A" - "A" . DURING COMPRESSION CYCLE GATE ROTOR TOOTH TRAPS AIR IN FLUTE OF MAIN ROTOR.

VIEW "A" - "A" JUST PRIOR TO END OF COMPRESSION CYCLE AIR TRAPPED IN MAIN ROTOR FLUTE HAS REACHED MAXIMUM COMPRESSION.

NOTES:

1. **ONLY THE MAIN AND GATE ROTORS ARE SHOWN IN VIEW "A" - "A" FOR CLARITY.**

2. **THE COMPRESSION CYCLE IS EXPLAINED FOR ONE GATE ROTOR ONLY. A SIMILAR CYCLE IS OCCURING WITH OTHER GATE ROTOR. THIS OFF-SET, TWO GATE ROTOR OPERATION PRODUCES A CONTINOUS DISCHARGE OF COMPRESSED AIR.**

Figure 3-1. Compression Cycle

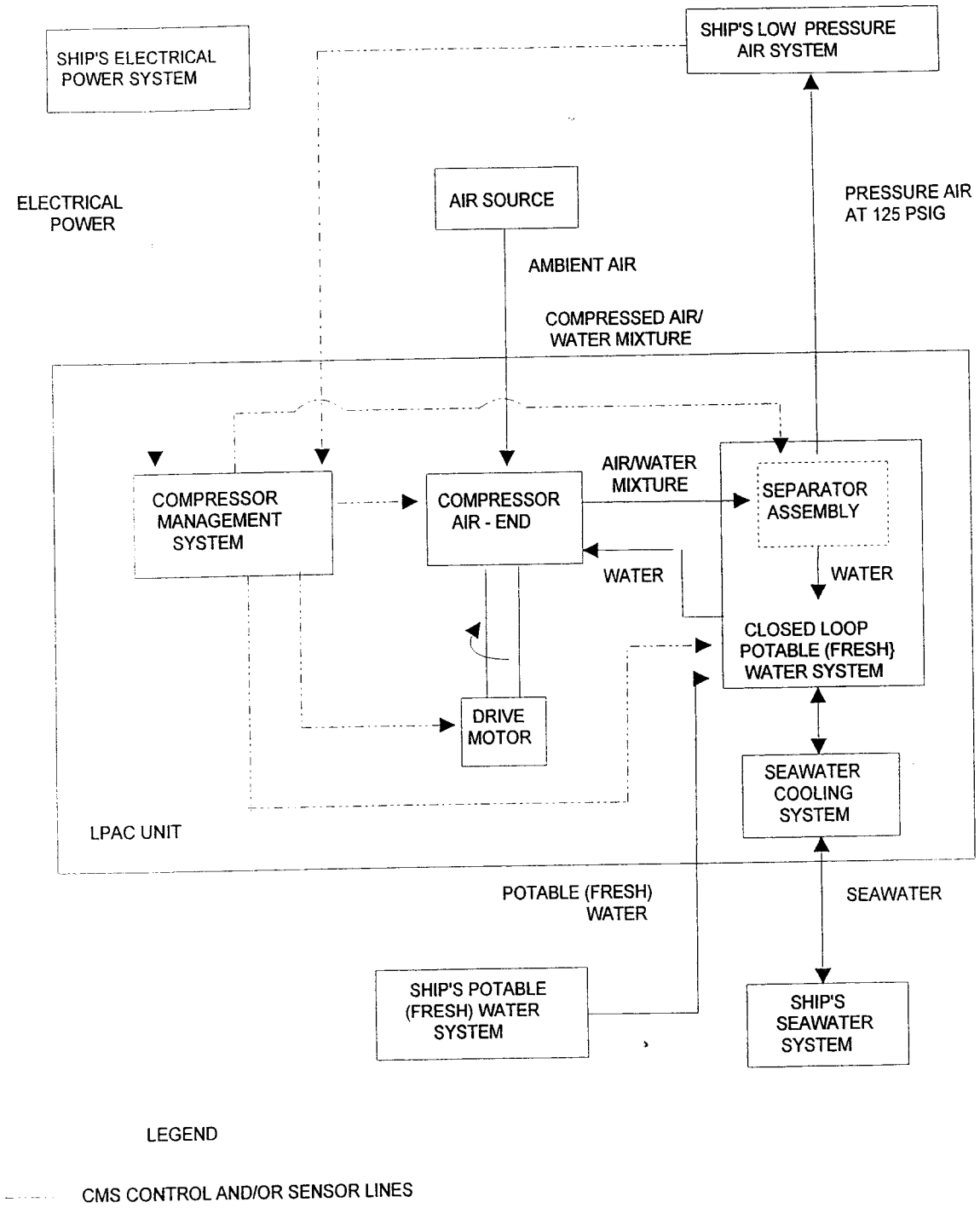


Figure 3-2. LPAC Functional Block Diagram

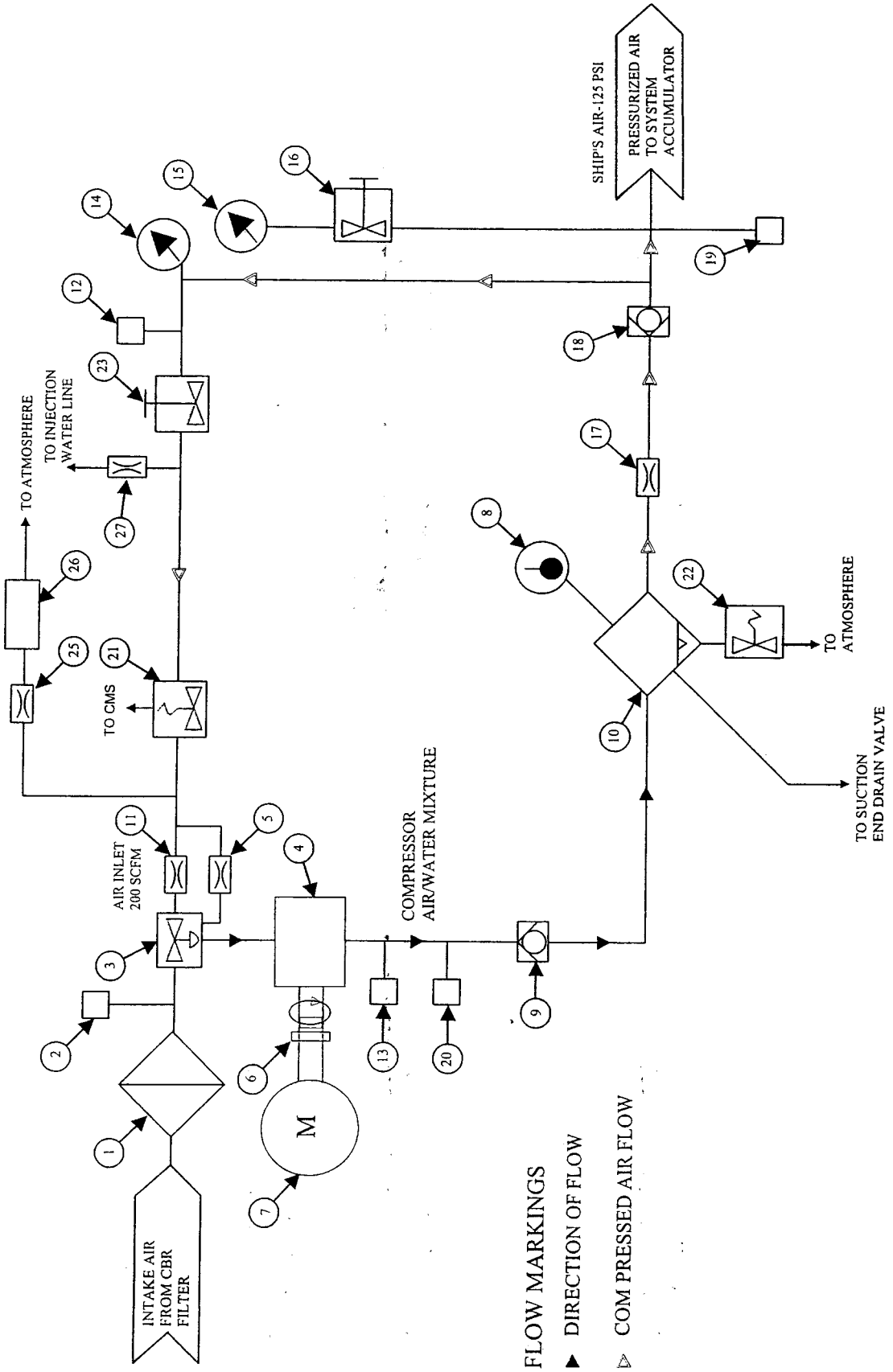
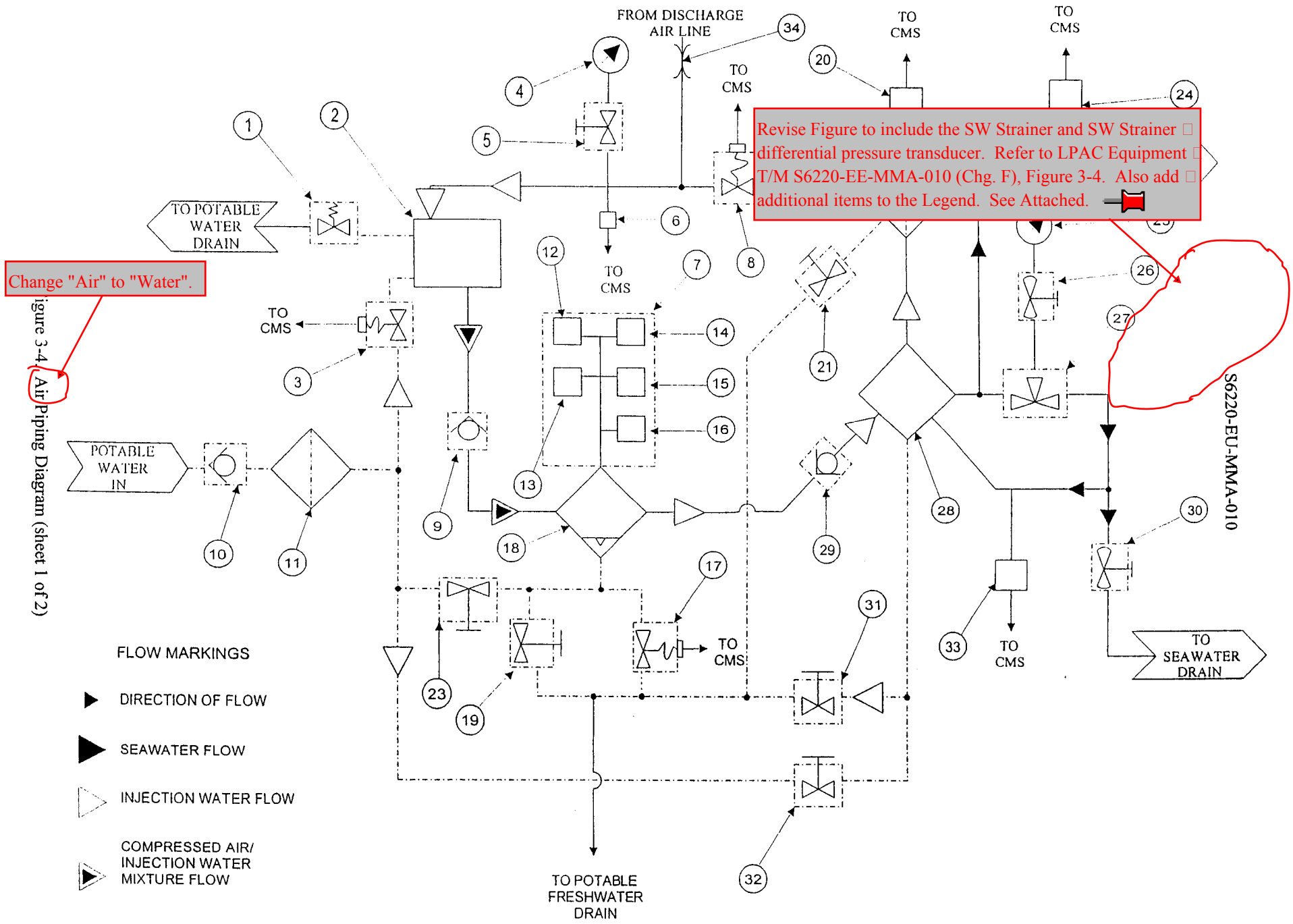


Figure 3-3. Air Piping Diagram (sheet 1 of 2)

LEGEND

1. AIR INLET FILTER
2. AIR INLET FILTER PRESSURE POP-UP INDICATOR
3. UNLOADER VALVE
4. COMPRESSOR ASSEMBLY
5. FLOW-METERING ORIFICE
6. DRIVE COUPLING
7. DRIVE MOTOR
8. DISCHARGE AIR TEMPERATURE GAUGE
9. AIR-END DISCHARGE CHECK VALVE
10. SEPARATOR ASSEMBLY
11. UNLOADED OPERATION FLOW-METERING ORIFICE
12. DISCHARGE AIR PRESSURE TRANSDUCER
13. DISCHARGE AIR HIGH-TEMPERATURE SHUT-DOWN SWITCH
14. DISCHARGE AIR PRESSURE GAUGE
15. SHIPBOARD AIR PRESSURE GAUGE
16. SHIPBOARD AIR PRESSURE GAUGE VALVE
17. FLOW ORIFICE
18. LPAC TO SHIP SYSTEM CHECK VALVE
19. SHIPBOARD AIR PRESSURE TRANSDUCER
20. RTD DISCHARGE AIR TEMPERATURE ELEMENT
21. BLOWDOWN VALVE
22. HIGH-PRESSURE RELIEF VALVE
23. DISCHARGE AIR PRESSURE GAUGE VALVE
24. RELIEF VALVE
25. METERING ORIFICE
26. MUFFLER
27. ORIFICE

Figure 3-3. Air Piping Diagram (sheet 2 of 2)



Change "Air" to "Water".

Revise Figure to include the SW Strainer and SW Strainer differential pressure transducer. Refer to LPAC Equipment T/M S6220-EE-MMA-010 (Chg. F), Figure 3-4. Also add additional items to the Legend. See Attached.

Figure 3-4. Air Piping Diagram (sheet 1 of 2)

LEGEND

1. SUCTION-END DRAIN VALVE
2. COMPRESSOR ASSEMBLY
3. WATER MAKE-UP / INJECTION VALVE
4. INJECTION WATER PRESSURE GAUGE
5. INJECTION WATER PRESSURE GAUGE VALVE
6. INJECTION WATER PRESSURE TRANSDUCER
7. WATER LEVEL SWITCH
8. SHUT-OFF / INJECTION WATER VALVE
9. AIR END DISCHARGE CHECK VALVE
10. POTABLE WATER SYSTEM CHECK VALVE
11. INLET WATER FILTER
12. WATER LEVEL HIGH SWITCH
13. WATER LEVEL LOW SWITCH
14. WATER LEVEL HIGH SHUT-DOWN SWITCH
15. WATER LEVEL NORMAL SWITCH
16. WATER LEVEL LOW SHUT-DOWN SWITCH
17. TWO-WAY SEPARATOR ASSEMBLY DRAIN VALVE
18. SEPARATOR ASSEMBLY
19. SEPARATOR ASSEMBLY DRAIN VALVE
20. RTD INJECTION WATER TEMPERATURE ELEMENT
21. DRAIN AND SERVICING PRESSURE RELEASE VALVE
22. WATER FILTER ASSEMBLY
23. SEPARATOR ASSEMBLY FILL VALVE
24. RTD SEAWATER OUTLET TEMPERATURE ELEMENT
25. COOLER SEAWATER PRESSURE GAUGE
26. COOLER SEAWATER PRESSURE GAUGE VALVE
27. COOLER SEAWATER PRESSURE INLET/OUTLET VALVE
28. HEAT EXCHANGER ASSEMBLY
29. HEAT EXCHANGER BACK-FLOW CHECK VALVE
30. COOLER SEAWATER DRAIN VALVE
31. FILTER DRAIN VALVE
32. COOLER AND FILTER POTABLE WATER FILL VALVE
33. RTD SEAWATER INLET TEMPERATURE ELEMENT
34. ORIFICE

Figure 3-4. Water Piping Diagram (sheet 2 of 2)

Drive motor specifications are shown in Table 1-1.

3-3.2 Air-end Components. (Refer to Figure 3-3.) The air-end components consist of: the air inlet filter (1), compressor assembly (4); including the unloader valve (3); high-pressure relief valve (22); check valves (9 and 18); discharge air temperature gauge (8); flow orifice (17); pressure gauges (14 and 15); together with their associated gauge valves (16 and 23); pressure transducers (12 and 19); resistive temperature device (RTD) discharge air temperature element (20); discharge air high temperature shut-down switch (13); blowdown valve (21); and flow-metering orifices (5 and 11).

3-3.2.1 Air Inlet Filter (Refer to Figure 3-3.)

CAUTION

Contaminated air may cause damage to the LPAC compressor assembly (4) internal components. Do not operate the LPAC without the air inlet filter and/or CBR filter connected and a filter element in place.

Ambient air is drawn into the compressor assembly (4) through the air inlet filter (1). The air inlet filter (1) contains a replaceable element, which removes 10 micron or larger particles from the inlet air. It also contains an air inlet filter pressure drop pop-up (2), which pops-up to indicate a clogged filter element. The air inlet filter (1) also reduces compressor assembly (4) suction-end noise. A flange on the filter inlet allows the CBR filter to be used in conjunction with the air filter.

3-3.2.2 Unloader Valve. (Refer to Figure 3-3.) Inlet air is drawn through a flexible hose to the unloader valve (3) and into the compressor assembly (4). The unloader valve (3) is a spring-loaded, diaphragm type valve. The unloader valve (3) is opened by the suction of the compressor.

3-3.2.3 Compressor Assembly. (Index numbers below refer to Figure 3-3 unless otherwise indicated.) Inside the compressor assembly (4), a shaft mounted main rotor engages and drives two planar gate rotors (refer to Figure 3-1). Potable water, injected into the compressor suction-end, seals and cools the compressed air in the main rotor grooves. The injected water also lubricates the compressor assembly (4) moving parts. The meshing of the main and gate rotor gear teeth compresses the air/water mixture trapped in the main rotor grooves (refer to Figure 3-1). The compressed mixture is collected in an annular discharge cavity within the compressor housing. A single discharge cavity collects the compressed mixture discharged from both gate rotor housing discharge ports.

3-3.2.4 Pressurized Air Flow. (Refer to Figure 3-3.) From the compressor assembly (4) discharge cavity the compressed air/water mixture is discharged out the bottom of the compressor housing, through the air-end discharge check valve (9) and piped to the separator assembly (10). Within the separator assembly (10) the moisture is separated out and rerouted as injection water. An air-end discharge check valve (9) prevents the separator assembly (10) pressure from backing into the compressor assembly (4). The saturated and pressurized air passes through a demister pad in the separator assembly (4) and is discharged to the ship's low-pressure (LP) system accumulator for additional drying and use. A flow orifice (17) and a LPAC to ship system check valve (18) are installed in the discharge piping. The LPAC to ship system check valve (18) prevents pressure from the ship's LP system accumulator from backing into the compressor unit. The flow orifice (17) measures flow while maintaining minimum pressure within the compressor if air is being discharged into an open line or system. Maintaining a minimum pressure ensures ample water circulation within the compressor unit.

3-3.2.5 Unloader System. (Refer to Figure 3-3.) The unloader system consists of: the unloader valve (3), the blowdown valve (21), flow-metering orifice (5), unloaded operation flow-metering orifice (11), metering orifice (25) and muffler (26). In the automatic mode, when the shipboard air system pressure reaches the default high-pressure setting, the CMS resets the LPAC to the unloaded mode by de-energizing the blowdown valve (21). When de-energized, the blowdown valve (21) vents the compressor air-end to atmosphere through a hose containing a metering orifice (25) and muffler (26). The blowdown valve (21) also directs some air to the diaphragm side of the unloader valve (3), through the unloaded operation flow-metering orifice (11), closing the valve. This orifice is located in the tee fitting on the unloader valve (3) housing. Air is also directed to the suction side of the unloader valve (3) through the flow-metering orifice (5), to allow some air to the compressor side of the valve. The flow-metering orifice (5) is also located in the tee fitting on the unloader valve housing. Some air is also drawn in through an internally drilled bypass located in the internal casing of the unloader valve (3), allowing a slight flow of air to enter the compressor. The combination of the three orifices and the drilled bypass line will limit the compressor pressure to 50 psig during unloaded operation.

3-3.2.6 Air-End Controls, Indicators, and Safety Devices. (Refer to Figure 3-3.) A high-pressure relief valve (22) mounted on top of the separator assembly (10) prevents excess pressure from building up. There is also a high-pressure relief valve (22) mounted on the compressor assembly (4) preventing excess pressure from building-up within the compressor housing. A discharge air pressure gauge (14) and a shipboard air pressure gauge (15) mounted on the gauge panel provide continuous pressure readings. Each of the gauges is equipped with a gauge valve (23 and 16), so the associated gauge can be isolated for calibration or repair. A discharge air pressure transducer (12), shipboard air pressure transducer (19), and RTD discharge air temperature element (20) provide inputs used by the CMS to control the compressor operation. The pressure transducers are located on a panel behind the CMS. The RTD discharge air temperature element (20) is located in the discharge piping of the compressor assembly (4). In the event of an RTD or CMS failure, a discharge air high-temperature shut-down switch (13) located in the discharge piping of the compressor assembly (4) will shutdown the LPAC if discharge air temperature reaches 140 deg F.

3-3.3 Closed Loop Potable Water System. (Refer to Figure 3-4.) The closed loop potable water system consists of the separator assembly (18); fresh water side of the heat exchanger assembly (28); water filter assembly (22); inlet water filter (11); water level switch (7), with level switches (12, 13, 14, 15, and 16); manually-operated ball valves (19, 21, 23, 31, and 32); check valves (10 and 29); solenoid valves (3,8, and 17); suction-end drain valve (1); injection water pressure gauge (4); injection water pressure gauge valve (5); injection water pressure transducer (6); and RTD injection water temperature element (20).

3-3.3.1 Injection Water Flow. (Refer to Figure 3-4.) Potable water circulates through the closed loop as follows:

a) Injection water enters compressor assembly (2), mixes with inlet air, and is discharged from compressor assembly (2) along with compressed air.

b) Compressed air/water mixture is piped to separator assembly (18) where cyclonic action separates water from compressed air.

c) Separated water is collected in separator assembly (18) and re-circulated as injection water.

d) From separator assembly (18), collected water is piped to fresh waterside of heat exchanger assembly (28) for cooling.

e) Cooled water is piped to water filter assembly (22) for filtering prior to passing through shut-off/injection water valve (8) and again entering compressor assembly (2) to restart loop.

3-3.3.2 Control of Water Level. (Refer to Figure 3-4.)

CAUTION

Separator assembly (18) can contain pressure in excess of ship's potable water system pressure. Do not open separator assembly fill valve (23) unless LPAC is stopped and separator assembly (18) is at atmospheric pressure or well below ship's potable water system pressure.

Initially, potable water is manually added to the loop by opening the separator assembly fill valve (23) located on a manifold block below the CMS. Another manually-operated ball valve, the cooler and filter potable water fill valve (32), located on the same manifold block, is used to initially fill the potable waterside of the heat exchanger assembly (28) and the water filter assembly (22). A potable water system check valve (10) prevents LPAC potable water from backing into the ship's system. On the down streamside of the check valve is an inlet water filter (11) that filters the potable water added to the closed loop. For two seconds prior to start-up of the LPAC the CMS energizes the water make-up/injection valve (3), injecting potable water into the compressor assembly (2) for lubrication of internal air-end parts. When start-up occurs, the water make-up/injection valve (3) closes. This valve is also used by the CMS to automatically add potable water to the loop whenever a low water level in the separator assembly (18) is sensed. For two seconds, prior to start-up of the LPAC, the CMS energizes the shut-off/injection water valve (8), allowing potable water flow within the loop. This valve is de-energized one second before LPAC shutdown, stopping flow within the loop to prevent flooding of the compressor assembly (2). The shut-off/injection water valve (8) has a manually-operated actuator on the side. Whenever high separator assembly water is sensed, a two-way separator assembly drain valve (17), is energized by the CMS. This results in the automatic draining of excess water from the loop. A separator assembly drain valve (19), on the manifold block below the CMS, can be used to manually lower the separator assembly water level. Below the compressor assembly (2), on the base skid, is a suction-end drain valve (1), that closes as compressor assembly air pressure increases to 40 psig. When the compressor assembly (2), shuts-down, discharge air pressure bleeds down to atmosphere, the suction-end drain valve (1), opens, and water drains from the compressor. While the compressor assembly (2), is draining there is a 30 second time delay

before the compressor can be restarted. This delay ensures that the compressor assembly (2) is not flooded at start-up, overloading the drive motor.

3-3.3.3 Separator Assembly. (Refer to Figure 3-4.) In addition to separating injection water from compressed air, the separator assembly (18) serves as a reservoir to store the injection loop water. Water level within the separator assembly (18) is checked by means of a water level sight glass. The separator assembly (18) also contains a water level switch (7), used by the CMS to sense the separator assembly (18) water level. The water level switch (7) contains six magnetic reed switches, which are activated by float assemblies indicating water level to the CMS. Water level switch operation is detailed below:

a) Water Level High Shut-Down Switch (14):

   1) Contains two switches. One is normally closed, opening as water level rises to it. As a back up, a second normally open switch closes as the water level rises to it. Actuation of either switch will cause the CMS to shutdown the LPAC.

b) Water Level High Switch (12):

   1) This normally open switch closes as water rises to it. Activation causes the CMS to open two-way separator assembly drain valve (17). The CMS will maintain drain valve open until it senses that water level has dropped to and opened water level normal switch (15). Failure to detect water level high switch (12) closure or failure of two-way separator assembly drain valve (17) to activate would allow water level to rise to water level high shut-down switch (14) which would shut-down LPAC.

c) Water Level Normal Switch (15):

   1) This normally open switch closes as water level rises to it. Activation causes CMS to de-energize water make-up/injection valve (3), halting filling of separator assembly (18). The switch opens as water level drops to it. Its opening causes the CMS to de-energize two-way separator assembly drain valve (17), stopping separator assembly (18) draining.

d) Water Level Low Switch (13):

   1) This normally open switch closes as water level falls to it. This causes the CMS to energize water make-up/injection valve (3), adding make-up water to the loop. CMS will maintain water make-up/injection valve (3) open until it senses that water level in separator assembly (18) has risen to and closed the water level normal switch (15). Failure to detect water level low switch (13) opening or failure of water make-up/injection valve (3) to activate would allow water level to fall to water level low shut-down switch (16), which would shut-down LPAC.

e) Water Level Low Shut-Down Switch (16):

   1) A normally closed switch opens as water level falls to it. An open switch will cause CMS to shutdown LPAC.

3-3.3.4 Heat Exchanger Assembly. (Refer to Figure 3-4.) The heat exchanger assembly (28) contains 31 titanium plates, which separate the injection potable water from the seawater. Potable injection water from the separator assembly (18) is routed over one side of the plates. Seawater is routed over the other side of the plates. Excess injection water heat is transferred through the plate to the seawater, which carries it out of the heat exchanger assembly (28). Gaskets maintain a seal between the plates, preventing water crossovers between the injection water and seawater sides of the heat exchanger assembly (28). Specifications for the heat exchanger assembly (28) are shown in table 1-1. A heat exchanger back-flow check valve (29) prevents seawater from entering the separator assembly (18), in the event of a heat exchanger plate leak.

3-3.3.5 Water Filter Assembly. (Index numbers below refer to Figure 3-4 unless otherwise indicated.) The water filter assembly (22) contains a replaceable 20 micron filter element which removes dirt and other solid particles from the injection water. The injection water pressure gauge (4) and the discharge air pressure gauge (14, Figure 3-3) must be checked for any indication of a dirty water filter element. Normally, the injection water pressure is 10 to 12 psig below the discharge air pressure. An injection water pressure reading 0 to 25 psig below the discharge air pressure indicates a dirty water filter element, causing restricted water flow. A drain and servicing pressure release valve (21), located below the CMS, allows draining of the water filter assembly (22) for service.

3-3.3.6 Injection Water Loop Controls, Indicators, and Safety Devices. (Refer to Figure 3-4.) On the gauge panel above the PLC is an injection water pressure gauge (4) providing a continuous reading of the injection water pressure. An injection water pressure gauge valve (5), above the gauge, allows isolation of the gauge for calibration and servicing. An injection water pressure transducer (6), mounted on a panel behind the CMS and an RTD injection water temperature element (20) mounted on the top cover of the water filter assembly (22), provide inputs to the CMS.

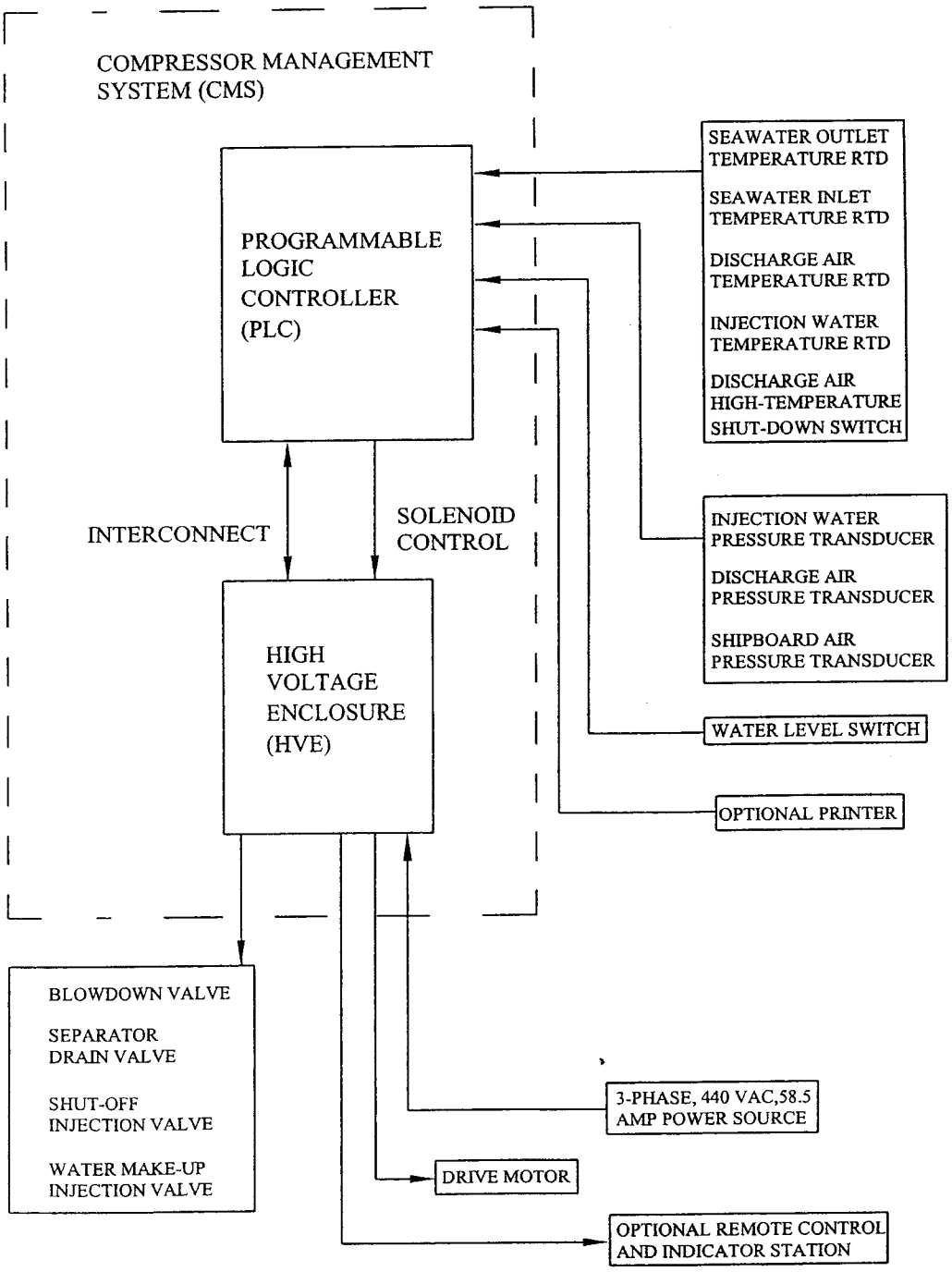


Figure 3-5. CMS Functional Interface Diagram

3-3.4 Seawater Cooling System. (Refer to Figure 3-4 unless otherwise indicated.) Seawater enters the heat exchanger assembly (28) through the bottom (seawater inlet) flange and discharges through the upper (seawater outlet) flange. A cooler seawater drain valve (30), mounted on the manifold block below the drive motor, is used to manually drain seawater from the heat exchanger assembly (28). Mounted on the end of the drive motor is a seawater gauge panel (17, Figure 2-2). On the panel are a cooler seawater pressure gauge (18, Figure 2-2), cooler seawater pressure gauge valve (19, Figure 2-2), and cooler seawater pressure gauge selector valve (27). This manually-operated selector valve is used to connect the cooler seawater pressure gauge (18, Figure 2-2) to either the heat exchanger assembly (28, Figure 3-4) seawater inlet or seawater outlet side. Once connected, the cooler seawater pressure gauge (18, Figure 2-2) provides a continuous reading of either the inlet or outlet side. It also isolates the cooler seawater pressure gauge (18, Figure 2-2) for calibration or service. A RTD seawater outlet temperature element (24, Figure 3-4), located in the outlet piping, and a RTD seawater inlet temperature element (33, Figure 3-4), located in the inlet piping, provides input to the CMS. Seawater pressure input is not provided to the CMS.

3-3.5 Compressor Management System (CMS). Figure 3-5 is a functional block diagram of the CMS. The CMS is a microprocessor based control system which checks and controls, either automatically or manually, the operation of the LPAC. It consists of two major assemblies: a programmable logic controller (PLC) and a high-voltage enclosure (HVE). Refer to Figure 1-2 for assembly locations.

3-3.5.1 PLC Controller. (Index numbers below refer to Figure 2-1 unless otherwise indicated.) The PLC is a system based on programmable logic chips and a touch-sensitive display screen providing the operator easier and more comprehensive control over the LPAC's internal settings.

The repair and maintenance philosophy of the LPAC is based on the generated fault and fatal fault PLC messages. The PLC has an RS-232 communications port for connection of an external printer/data logger, and also a standard RJ-45 Ethernet network connector to allow connection to the ship's internal local area network (LAN). The LAN provides remote warning or fault alarm messaging, and may also provide a limited remote control function. The printer/data logger is not part of the LPAC unit. The PLC operates as follows:

a) During normal operation, PLC monitors the LPAC temperatures, pressures, and cycle times.

b) Monitored values are compared with default parameters stored in PLC's memory to determine if the LPAC is operating within its design specifications.

c) When values outside stored parameters are detected, the PLC generates and displays a fault message on the PLC touchscreen display (3) and illuminates the red warn/fail indicator light (9). Warning faults are self-healing. When the sensed readings return to within normal (or programmed) operating parameters, the warning indication will be cleared. All warnings will be stored in the warning indication log file for historical record.

d) If the PLC detects that monitored condition will damage the compressor, it will generate and display a fatal fault message on the PLC touchscreen display (3) illuminating the red warn/fail indicator light (9) and shutting down the LPAC.

e) In normal operation, PLC monitors and automatically controls separator assembly (Figure 1-2) water level.

f) When operating in automatic mode, PLC will start and stop LPAC based on system demand without operator intervention.

g) When operating in manual mode, operator must start LPAC manually, by pressing the start pushbutton switch (6) each time air is demanded.

h) In manual mode, PLC continues to monitor compressor operation and stops LPAC when system pressure reaches the default high-pressure range setting.

3-3.5.2 CMS High-Voltage Electrical Enclosure (HVE). The HVE (Figure 6-26) contains the motor contactor (16, Figure 6-26). When closed, the motor contactor connects the 440 volt, 3-Phase, AC power to the LPAC drive motor, starting the unit. When opened, it disconnects the drive motor from power, stopping the unit. An overload relay (15, Figure 6-26) disconnects the drive motor from power anytime the motor draws excessive current. The overload relay can be reset by pressing the stop/reset pushbutton switch (7, Figure 2-1). Located on the HVE door is the battle override switch (10, Figure 2-1). This switch is used in an emergency whenever failure of system or LPAC components prevents either automatic or manual operation, or as crisis situations dictate. The battle override mode is initiated by pulling out the locking attachment and positioning the switch to ON (10, Figure 2-1). The LPAC will run until the battle override switch is positioned to OFF (10, Figure 2-1).

3-4 INTERACTION OF SUBASSEMBLIES.

3-4.1 Automatic or Manual Start-Up Sequence. (Index numbers below refer to Figure 2-1 unless otherwise indicated.) In the automatic or manual mode of operation the PLC controls LPAC start-up as follows:

a) In automatic mode, the PLC begins start-up when it senses that system pressure is below the default low-pressure range limit.

b) In manual mode, the PLC will only begin start-up when it senses that system pressure is below the default low-pressure range limit and the start push button switch (6) has been pressed. If the start push button switch (6) has been pressed while system pressure is at the default high-pressure range limit the PLC will abort LPAC start-up and display

"NO START: AT HI PRESSURE LIMIT" for 5 seconds.

It will then display "COMPRESSOR READY FOR START".

c) The PLC next checks to determine that no fatal (LPAC damaging) conditions exist. If a fatal condition is detected, the PLC will abort LPAC start-up and will display a fatal fault message describing fault condition.

d) The PLC next determines that it contains valid pressure sensor calibration limits. If calibration limits are not found, the PLC loads the default values stored internally.

e) On first LPAC start after AC power is turned ON, the PLC will display the message

"PRE-START DRAINING IN PROGRESS" for 20 seconds prior to activating the solenoid valves.

The PLC next energizes the water make-up (3, Figure 3-4), blowdown (21, Figure 3-3), shut-off (8, Figure 3-4) solenoid valves, and the main contactor start delay timer. During this time, water is injected into the compressor air-end to pre-wet the compressor assembly air-end components. A delay of 20-seconds will occur during the pre-wetting phase.

f) On completion of preset main contactor start delay, the main contactor closes and water make-up/injection valve (3, Figure 3-4) de-energizes. If main contactor fails to close, PLC aborts LPAC start-up and displays

"START ABORT: PRI CONTACTOR FAULT".

g) A 30 second restart delay timer is also activated to allow time for water to drain from compressor assembly air-end. If PLC detects main contactor closure it displays

"NORMAL START-UP COMPLETED"

h) The compressor drive motor starts. The motor running indicator light (8), glows and hours meter (11) starts to run.

3-4.2 Automatic and Manual Running Sequence. (Index numbers below refer to Figure 3-3 unless otherwise indicated.) Compression takes place in a single stage through the interaction of a rotary screw flute and its mating gate rotor tooth. Potable water injected into the compressor compartment cools the compressed air, seals the compression cavities, and lubricates the mating parts (refer to Figure 3-1). The compression cycle is as follows:

a) At start of compression cycle, ambient air is drawn through air inlet filter (1) and unloader valve (3), into open rotary screw flutes where it mixes with injected water. As the screw turns, its flutes engage gate rotor teeth and compression begins.

b) Intake air and injection water mixture is trapped in a cavity formed by gate rotor tooth, screw flute and compressor casting (refer to Figure 3-1). Water forms a seal between turning screw, gate rotor tooth and compressor casting. Screw flute depth is tapered with deepest portion at suction end. Screw flute depth tapers to zero at the discharge end. Screw flute sides end before end of screw rotor to allow discharge of pressurized air/water mixture and passage of gate rotor tooth.

c) As screw continues to turn, engaged gate rotor tooth forces trapped air and water into a gradually decreasing screw flute cavity. Decreasing cavity volume causes increased air/water mixture pressure.

d) As engaged gate rotor tooth approaches discharge end of screw flute, cavity volume is minimum and pressure of the trapped air and water mixture is maximum. This point is engineered to occur just as screw flute cavity reaches compression chamber discharge port. At this point compression ceases; compressed mixture is discharged and gate rotor tooth sweeps the engaged screw flute volume to zero.

e) While compression process described above is occurring in half of compressor, a similar process is taking place in the other half, utilizing a second set of gate rotor teeth. Each turning screw flute is used twice-per-revolution of screw shaft (once by each gate rotor tooth assembly). This results in one screw

flute cavity reaching the discharge point just as the other screw flute cavity completes its discharge and results in a continuous discharge of compressed air.

f) The compressed air and water mixture is piped to separator assembly (10). The pressurized air is separated from the water and discharged to ship's LP air system. The water is collected for reuse after it has been cooled and filtered.

3-4.3 Automatic and Manual Control Sequence. (Index numbers below refer to Figure 2-1 unless otherwise indicated.) While the LPAC is running in automatic or manual mode, the PLC checks the installed sensors, compares the readings obtained with stored operating limits and displays the results for the operator as follows:

a) If readings outside stored fault limits are detected, PLC will generate a warning fault message to operator and warn/fail indicator light (9) will glow. Warning faults are self-healing. When the sensed readings return within stored default limits, warning fault indication and message are cleared. If PLC determines that fault is one that is dangerous or could cause LPAC damage it generates a "FATAL" fault message to operator and shuts-down LPAC. LPAC cannot be restarted until fatal fault has been cleared and PLC reset by pressing stop/reset push button switch (7).

b) In automatic mode, when PLC senses that system pressure has reached default high-pressure range limit, it resets LPAC for 10 minutes of unloaded operation. To begin unloaded operation, the PLC de-energizes the blowdown valve (21, Figure 3-3), causing unloader valve (3, Figure 3-3) to close. With unloader valve (3, Figure 3-3) closed, compressor draws air through a flow-metering orifice (5, Figure 3-3), maintaining internal compressor pressure at 50 psig. The LPAC to ship system check valve (18, Figure 3-3), in discharge air line prevents air back-flow from ship's LP system accumulator to compressor during unloaded operation.

c) If during unloaded operation, PLC senses that system pressure has fallen to lower limit of default pressure range or detects the start pushbutton switch (6) has been pressed, it energizes blowdown valve (21, Figure 3-3), opening unloader valve (3, Figure 3-3). This terminates unloaded operation and returns LPAC to normal operation. Unloaded operation only occurs during the automatic mode.

d) PLC initiates LPAC shutdown after 10 minutes of unloaded operation or in the manual mode when it senses the stop/reset pushbutton switch (7), has been pressed.

When the stop/reset pushbutton switch (7), is used to halt operation in the Auto mode, a FAULTED shutdown will occur, and the display will show the message

"**SET TO MANUAL THEN PRESS RESET**"

This prevents re-starting of the compressor until the stop/reset pushbutton switch (7) has been pressed, clearing the fault.

To begin shutdown, the PLC de-energizes the shut-off/injection water valve (8, Figure 3-4). Two seconds later, the PLC opens the main contactor and displays

"MAIN CONTACTOR SHUT-DOWN"

Next, the PLC de-energizes remaining solenoid valves and starts a 30 second cycle of draining water from compressor assembly air-end. During 30 second draining cycle PLC displays

"AIR-HEAD DRAINING IN PROGRESS"

At end of the draining cycle, PLC displays

"SHUT-DOWN COMPLETE" for 5 seconds then

"COMPRESSOR READY FOR START."

3-4.4 Battle Override Operation.

CAUTION

No safeties are active during Battle Override Operation. It does not check or shutdown for any compressor failure. Operator must manually control water level.

CAUTION

During Battle Override Operation, the only way to shut off the compressor is by positioning the Battle Override Switch to OFF, or securing power at the breaker.

NOTE

When the LPAC is placed in the Battle Override Mode, a summary fault will be sent to any remote monitor the LPAC is connected to.

(Refer to Figure 2-1.) When the Battle Override mode is initiated by pulling out the locking attachment and positioning the BATTLE OVERRIDE switch to ON (10), the main contactor closes and the LPAC starts running. When the PLC senses that BATTLE OVERRIDE MODE has been set, it ceases to control LPAC operation and displays "BATTLE OVERRIDE ACTIVE." The LPAC will continue to run and supply compressed air to the ship system until the BATTLE OVERRIDE switch is set to OFF (10), and the LPAC returns to the normal run mode.

3-5. PROGRAMMABLE LOGIC CONTROLLER (PLC)

For first time use, insert spelled out acronym for "SEM".

3-5.1 PLC Overview. The PLC t
the model STAR 200 LPAC has been designed to replace earlier versions of the mini-microprocessor chip-based (SEM) CMS and HVE. This new PLC provides a simplified component wiring arrangement, improved reliability, and a significant reduction in the troubleshooting and repair of the STAR 200 LPAC unit.

3-5.2 System Description. The housing for the new controller unit (replacing the earlier CMS housing) is identical in form and fit. The two-line light emitting diode (LED) display has been replaced with a touch-sensitive, flat panel color LCD display screen. The new display incorporates all the previous warning messages into a series of touch-drive
an enhanced alert me

For first time use, insert spelled out acronym for "SEM".

The PLC is a 24-volt device, using less than 24 watts of power. It uses an Allen Bradley SLC 500 series, 7-slot microprocessor using 5/05 chipset circuit boards.

The PLC is equipped with two communications ports. A RS232 serial port is used to communicate with the color display unit. The unit is also installed with a standard RJ45 Ethernet 10baseT connection port used to interface with the ship's LAN to send communications and alert to remote monitoring devices.

3-5.3 Power Conditioning. Power transients are common during the conversion from shore-based to ship-based power sources. The PLC and color touchscreen display are protected using two tiers of power isolation from the 440-volt ship's power source. The HVE contains a 440-volt to 110-volt linear power conditioner that provides the first tier of power isolation. The CMS contains a 110-volt to 24-volt linear power supply that adds the second tier of power isolation.

3-5.4 PLC Display User Screens. Operation of the model STAR 200 LPAC with the PLC touchscreen display is identical (in function) to the earlier CMS configuration.

NOTE

The diagrams in this manual have, however, been redrawn and renumbered to reflect the simplified design of the STAR 200 LPAC unit. Use care when referencing part numbers on the new unit to ensure current diagrams and references are being used.

The PLC touchscreen display (3, Figure 2-1) provides superior human interface-to-machine (HIM) enhancements that will significantly reduce operator training. It will also greatly decrease the complexity in

The touchscreen display has the following menu screens available for operator use:

1. Main Screen
2. Run Screen
3. Log Data Screen
4. Ship's Air Status Screen
5. Separator Tank Screen
6. Maintenance Mode Screen
7. Program Mode Screen
8. Program Fault Setpoints
9. Program Pressure Sensor Calibration
10. Trending Screens
11. Alarm History Screens

3-5.4.1 Main Screen. Upon power-up, the PLC and touchscreen display go through an internal checksum test. The two units then establish a communications session with each other. The touchscreen display will default to the MAIN SCREEN (refer to Figure 2-4.1) upon power-up for approximately 15 seconds. After that time, it will automatically switch to the RUN SCREEN (refer to Figure 2-4.2).

The operator can begin LPAC operations from this screen, or return to the MAIN SCREEN to access the four operational menus (refer to Figure 2-4.1).

3-5.4.2 Run Screen. The RUN SCREEN (refer to Figure 2-4.2) consists of four screens. The first screen displays the LPAC status, warning faults, fatal faults, elapsed loaded run time, unloaded run time remaining before automatic shutdown, and the restart delay times.

This display will always indicate the status of the LPAC (regardless of whether it is in NORMAL OPERATION or BATTLE OVERRIDE modes).

3-5.4.3 Log Data Screen. The LOG DATA SCREEN (refer to Figure 2-4.3) contains information gathered on the LPAC log sheet during crew watch duty. Temperatures are displayed for the Injection Water, Compressor Discharge Air, Seawater Cooling Inlet, and Seawater Cooling Outlet. Pressures reading are displayed for the Injection Water, Compressor Discharge Air, Shipboard Reserve Air, Shipboard Low Limit Start, and Shipboard High Limit Stop settings. The number of Motor Starts and Loaded Run Hours are also displayed.

The Separator Tank Status is displayed, which indicates if the separator tank is filling or draining , or whether any fatal faults have occurred due to separator drain logic conditions.

3-5.4.4 Ship's Air Status Screen. The SHIP'S AIR STATUS SCREEN (refer to Figure 2-4.4) shows the Discharge Air and Shipboard Air Pressure conditions in bar graph form (as well as in set point form for associated warnings and fatal faults).

3-5.4.5 Separator Tank Screen. The SEPARATOR TANK SCREEN (refer to 2-4.5) displays a graphical representation of the water level based on level switch sensors (located within the water tank). The tank status is shown indicating any fill or drain activities, and the status of the four solenoid valves.

3-5.4.6 Maintenance Mode Screen. MAINTENANCE MODE SCREEN (refer to Figure 2-4.8) displays the results of various tests performed when this submenu is selected. Among the tests performed are the Motor Jog and Solenoid Valve Test. The Shipboard Low Limit Start and Shipboard High Limit Stop pressure ranges can be set from either one of three preset (standard default) ranges, or can be entered by the operator as custom settings. This screen can display all Maintenance Timers and System Default Settings. If this mode is entered while the LPAC is running, the controller will automatically unload the LPAC.

3-5.4.7 Program Mode Screen. The PROGRAM MODE SCREEN (refer to Figure 2-4.17) permits the operator to enter the program mode to change existing LPAC settings. This screen will require a password to permit entry. After user verification, the PLC will automatically shutdown the LPAC to prevent damage during the data entry session. Normal restart can occur when the PROGRAM MODE SCREEN is exited.

3-5.4.8 Program Fault Setpoints. The PROGRAM FAULT SETPOINTS SCREEN (refer to Figure 2-4.22) will allow all Pressure and Temperature Warnings and Fatal Fault Limit setpoints to be changed to the factory default values (or a custom setting). All Delay Timer setpoints can be set to default or custom settings. All Maintenance Timers can be set indicating Water or Air Filter Hour maintenance, as well as General and Overhaul Timers to be adjusted. All Separator Drain Logic settings can be set to default or custom settings. The Unloaded Run Time setting can be set to any value (between 1 minute to 60 minutes – it uses a default setting of 10 minutes).

3-5.4.9 Program Pressure Sensor Calibration The PROGRAM PRESSURE SENSOR CALIBRATION SCREEN (refer to Figure 2-4.19) allows the Pressure Sensor Calibration setting to be monitored (as zero or factory preset values). The PLC contains logic to prevent damage to the compressor due to Resistive Temperature Device (RTD) Temperature or Pressure Sensor failure.

3-5.4.10 Trending Data Screens. The TRENDING DATA SCREENS (refer to Figure 2-4.16) can be added to allow viewing of the actual operating trends of various compressor functions. The first screen allows viewing of the Load/Unload Cycle as it follow the Shipboard Air Pressure fluctuations over the last ten minutes with consecutive screens showing the same data over the last hour and the last day. This screen shows when the Motor was running or shutdown.

3-5.4.11 Alarm History Screens. The ALARM HISTORY SCREEN (refer to Figures 2-4.6 and 2-4.7) will show the last 50 events that generated a Warning or a Fatal Fault, the time it occurred, the time it was cleared, and if whether or not that condition is still present. This screen shows a history of what conditions may have led to a Fatal Shutdown and how long those conditions may have been preceded by a Warning. ALARM HISTORY sub screens show the total number of Warnings or total number of Fatal Faults that have occurred over the operating history of the compressor.

CHAPTER 4
SCHEDULED MAINTENANCE

4-1. INTRODUCTION.

Scheduled maintenance procedures are furnished in the planned maintenance system (PMS). For information concerning maintenance procedures refer to those maintenance index pages (MIP) containing expanded ship's work breakdown structure (ESWBS) number 5515.

CHAPTER 5
TROUBLESHOOTING CMS AND ELECTRICAL COMPONENTS

5-1. INTRODUCTION

This chapter contains information to assist the technician in locating a malfunction or identifying a potential fault with the model STAR 200 low-pressure air compressor (LPAC). Provided in this chapter is a description of the compressor management system (CMS) and its sub-level components. A detection of problems section outlines basic troubleshooting techniques. Trouble isolation and testing procedures are included to assist the operator in the isolation of problems. They are written with the most likely and easiest diagnosed probable cause. Subsequent isolation to a faulty component and repair actions may involve higher levels of maintenance. This section contains warnings and fatal faults generated by the programmable logic controller (PLC) with accompanying descriptions. A CMS and electrical components troubleshooting chart is also included, showing component-generated warnings and fatal faults as well as some general component failures.

5-1.1 Description and Subassemblies Section Description. This section describes the CMS and its sub-level components. The high voltage enclosure (HVE) is broken down to the component level with component description and functionality. The PLC control panel assembly components, including the PLC touchscreen display (19, Figure 6-24). The PLC controller assembly (Figure 6-25) containing the CPU or "brains" of the system is also fully described as are the replaceable input/output (I/O) cards (Figure 7-2).

For first time use, insert spelled out acronym for "CPU".

5-1.1.1 Detection Of Problems Section Description. This section provides troubleshooting guidelines to assist in the basics of troubleshooting the CMS and related components. Troubleshooting safety guidelines are included to alert troubleshooting personnel to potentially hazardous and dangerous situations that they may encounter.

5-1.1.2 Trouble Isolation and Testing Section Description. This section is provided to aid in the analysis and resolution of CMS and related component failures. This section addresses PLC internal component failure isolation, HVE component failure isolation, PLC external component failure as well as drive motor trouble isolation. The foldout wiring diagrams referenced should be used in conjunction with the text to aid in resolving CMS failures.

5-1.1.3 Warning and Fatal Faults Section Description. Contained in this section are warnings and fatal faults generated by the PLC, alerting the operator to the status of the LPAC. All warnings and faults with the most likely cause that generated them are described.

5-1.1.4 CMS and Electrical Components Troubleshooting Chart Description. A troubleshooting chart is included at the end of this chapter providing a troubleshooting summary and quick reference. This chart shows the relationship between various PLC warning and fatal fault screens and what might have generated them. This chart also addresses what the most likely causes are if the PLC does not light up or energize or if the LPAC stops suddenly without completing an intended operation.

5-1.2 Electrostatic Discharge Protection and Sensitivity. The model STAR 200 LPAC has electronic components that have been determined to be electrostatic discharge sensitive (ESDS). This means these components are extremely susceptible to damage from static charges generated by personnel, equipment and packaging that come in contact with or are near ESDS components. handling, transportation and packaging for protection from ESDS damage. Whenever the PLC display cover (18, Figure 6-24) is opened, ships' force should wear a static-free wristband. Whenever an I/O card is removed from the 7-slot chassis (Figure 7-2) it should be placed in a static-free holding envelope. Whenever handling, repairing, packaging or transporting ESDS items proceed as follows:

For first time use, insert spelled out acronym for "I/O".

a) Perform all repairs of ESDS items on ESDS protected workbenches.

b) Wear a static-free wristband prior to handling ESDS items.

c) Use only soldering irons having grounded tips and ESDS protective solder extractors for soldering operations.

d) Ensure that all test equipment, electrical tools, and containers used on ESDS protected areas are grounded before and during use.

e) Ground all leads of test equipment prior to energizing and before probing ESDS component terminals.

f) Upon completion of replacement of an ESDS assembly, repackage defective ESDS item in

protective packaging material and ensure proper marking.

g) Place ESDS assemblies in protective tote boxes or trays for transporting.

For more information on handling and packaging of ESDS sensitive devices refer to the following:

DOD-STD-1686, Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices).

DOD-HDBK-263, Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices).

5-2. DESCRIPTION AND SUBASSEMBLIES

This section describes the compressor management system (CMS) and its sub level components.

5-2.1 High Voltage Enclosure (HVE). (Refer to FO-3 for circuit details and Figure 6-26.) The HVE is the electrical source for operation of the low-pressure air compressor (LPAC), transforming 440VAC 3-phase electrical supply to 110VAC for component and system use. The HVE is an electrical enclosure assembly containing a power conditioning transformer, motor contactor, overload relay, battle override switch, electrical arrestors, fuses and associated connectors and terminal strips for shipboard interface.

5-2.1.2 Power Conditioner Transformer. The power conditioner transformer (1, Figure 6-26) is a step-down transformer supplying 110 VAC system voltage. With 440, 3- Phase VAC at its primary coil from ship's power to motor, it outputs regulated 110 VAC at its secondary. Used with the motor to power motor loads, the transformer provides 110 VAC to the ON/OFF selector switch (9, Figure 6-24), located on the PLC control panel assembly. In addition, the power conditioner transformer provides 110VAC to the motor contactor coil, battle override switch, the blowdown, and shut off solenoid valves.

5-2.1.3 Motor Contactor. The motor contactor (16, Figure 6-26) is a short circuit protection device used to switch loads. It has a 110VAC coil, when energized, connects the 440, 3-Phase VAC to the LPAC drive motor, starting the unit. When opened, the motor contactor disconnects the drive motor from power, stopping the unit.

5-2.1.3.1 Overload Relay. Directly mounted to the motor contactor is the solid-state overload relay (15, Figure 6-26). Anytime the motor draws excessive amperage (resulting in excessive heat being sensed) the overload relay opens, disconnecting the motor from power. Besides providing thermal overload protection, the overload relay provides jam and ground fault tripping, phase loss protection and can be tested and reset.

5-2.1.4 Battle Override Switch. (Refer to FO-3 for circuit details.) Contained on the door of the HVE is the battle override switch (17, Figure 6-26 and Figure 6-27). The battle override switch provides emergency operation of the LPAC. When the locking attachment (6, Figure 6-27) is removed from the battle override selector switch (4, Figure 6-27) on the front of the HVE door the battle override selector switch (4, Figure 6-27) can be set to the ON position. This allows the system to bypass the PLC, closing the motor contactor, starting the LPAC. It should be used for battle conditions, or when such extreme measures are warranted by circumstance. It should not be used as an override for any other reason. Starting this mode of operation will disengage all of the LPAC's safety features, ability to automatically control functions, and will provide power to the motor. It is not intended as a tool for conducting diagnostics.

CAUTION

No safeties are active during Battle Override Operation. It does not monitor or shutdown for any compressor failure. The water level must be manually controlled by an operator.

CAUTION

Insert "or secure power at the breaker". only way to shut down the LPAC is by positioning the battle override selector switch to OFF.

NOTE

Battle Override Mode will subject the LPAC to substantial risk of catastrophic damage should an undetected problem exist. Battle Override Mode should be reserved for battle conditions only.

The battle override circuit consists of one SPST rotary toggle switch containing six contact blocks. Four contact blocks directly switch 110 VAC to each leg of the blowdown and injection water solenoid valves. A fifth contact block switches 110 VAC directly to the motor contactor. The last contact block provides a signal to the

PLC indicating an active battle override condition. As long as the power conditioner transformer (1, Figure 6-26) is working, the battle override feature is available.

5-2.1.5 Miscellaneous Safety Components. Providing finger and shock protection, terminal cover kits (8, Figure 6-26) are installed on the motor contactor (16, Figure 6-26).

5-2.1.5.1 Fuses (Refer to FO-3 for circuit details.) Fuses are circuit protection devices, rated for various voltages and amperages. When current exceeds the rating of the fuse, resulting in excessive heat, the fuse "blows" opening the circuit and preventing damage to components. Fuses F1 and F2 (28, Figure 6-26) are 500V 10Amp fuses providing primary circuit protection for the power conditioning transformer. Fuses F3, F4, F5, F6 and F7 (29, Figure 6-26) are 500V 3Amp fuses. F3 provides protection for the power conditioner transformer (1, Figure 6-26) secondary circuit as well as internal component protection. Fuse F4 provides protection for the blowdown solenoid valve circuit. Fuse F5 provides protection for the tank drain solenoid valve circuit. Fuse F6 provides protection for the make up solenoid valve circuit. Fuse F7 provides protection for the shut off solenoid valve circuit.

5-2.1.5.2 Electrical Arrestors/Varistors. Providing further circuit protection are electrical arrestors, insulated varistors and a 120VAC filter varistor. These components are surge suppressors, protecting components from overvoltages or "spikes". Electrical arrestors RV1, RV2 and RV3 (12, Figure 6-26) protect the drive motor from overvoltage damage. RV4 protects the power conditioner transformer (1, Figure 6-26) from overvoltage damage. RV5 protects the blowdown solenoid valve from overvoltage damage. RV6 protects the tank drain solenoid valve, RV7 protects the shut off solenoid valve, and RV8 protects the make up solenoid valve. RV9 offers overvoltage protection for the motor contactor's (16, Figure 6-26) 110VAC coil. The 120VAC filter varistor (9, Figure 6-26) protects the internal circuitry against temporary rises in voltage levels due to peak motor starting, switching and normal cycling of the LPAC.

5-2.1.5.3 Terminal Strips. The HVE contains three terminal blocks (23, Figure 6-26) providing connection points for indicators and controls as well as troubleshooting points for component isolation.

5-2.2 Programmable Logic Controller (PLC). The PLC is designed to operate the LPAC in either the automatic or manual mode, monitoring all functions of the LPAC such as pressures, temperatures and tank status. System status can be determined by watching the touchscreen display (19, Figure 6-24) on the PLC control panel assembly. The PLC "pulls in" the motor contactor coil, closing the circuit and starting the LPAC. The PLC is designed to directly switch all solenoid valves, motor contactor, lights and all external ship interface signals. The PLC senses switch positions (MAN/AUTO, START, STOP, Battle Override) throughout the compressor system, feedback from shipboard interface and internal feedback sensing for control. The PLC is also used to sense voltage and current as well as temperature RTD inputs. In addition, the PLC converts 110VAC to 24VDC for distribution to the PLC control panel assembly (1, Figure 6-24) and to the PLC power supply 24VDC input control module. The PLC system consists of a 7 slot chassis containing the PLC 24VDC input power supply, SLC 5/05 CPU, three input cards, two relay output cards and a S6 basic module card (Figure 7-2).

5-2.2.1 Control Panel Assembly. (Refer to Figure 6-24.) The PLC also has a control panel assembly (1) containing a 6" touchscreen display (19), hours meter (15), an ON/OFF selector switch (9), MAN/AUTO selector switch (10), a START pushbutton switch (11), a STOP/RESET pushbutton switch (12), a MOTOR RUNNING indicator light (13) and a WARN/FAIL indicator light (14).

5-2.2.1.1 ON/OFF Selector Switch. (Refer to FO-2 for circuit details.) The ON/OFF selector switch (9, Figure 6-24) energizes the LPAC. A 2-position selector switch, non-illuminated with knob lever and round metal bezel that directly receives 110VAC from the HVE. When positioned to ON, one leg of 110VAC is switched to 1J2 providing voltage to shut off, make up, tank drain and blowdown solenoid valves. In the ON position, the ON/OFF selector switch (9, Figure 6-24) also provides 110VAC to the primary coil of the PLC power supply. The power supply secondary coil outputs regulated 24VDC for distribution to the PLC control panel and to the PLC power supply 24VDC input control module.

5-2.2.1.2 MAN/AUTO Selector Switch. (Refer to FO-2 for circuit details.) The MAN/AUTO selector switch (10, Figure 6-24) allows selection of either manual or automatic control of the LPAC. It is also a 2-position selector switch, non-illuminated with knob lever and round metal bezel. In the MAN position, the LPAC will not start until the START pushbutton switch (11, Figure 6-24) is pressed. The compressor will continue to run until the STOP/RESET pushbutton switch (12, Figure 6-24) is pressed or high accumulator pressure is detected by the PLC. In the AUTO position, the automatic mode, the compressor starts without user assistance when low pressure is detected. When shipboard air pressure reaches demand level, the PLC opens the unloader solenoid valve, which activates the suction unloader valve, and places the compressor in the unloaded mode. If no system demand is made within the following ten minutes or the time set on the unloader run timer, the PLC resets the LPAC in the STANDBY mode, the compressor is placed in standby

and the compressor is bled down to atmospheric pressure. In the automatic mode, the compressor also can be stopped by pressing the STOP/RESET pushbutton switch (12, Figure 6-24) on the PLC control panel assembly (1, Figure 6-24). To restart after activating in AUTO, must reset by pressing STOP/RESET pushbutton switch (12, Figure 6-24).

5-2.2.1.3 START Pushbutton Switch. The START pushbutton switch (11, Figure 6-24) is used to manually start the LPAC in both automatic and manual modes of operation. When pressed, this momentary-action switch completes the 24VDC circuit, starting the LPAC. This switch is a round, metal flush, operator-action, non-illuminated switch with metal bezel.

5-2.2.1.4 STOP/RESET Pushbutton Switch. The STOP/RESET pushbutton switch (12, Figure 6-24) is used to manually stop the LPAC in both automatic and manual modes of operation. A momentary-action switch, when first pressed opens the 24VDC circuit, stopping the LPAC. When pressed again, closes the overload relay (15, Figure 6-26), starting the LPAC.

5-2.2.1.5 MOTOR RUNNING Indicator Light. The MOTOR RUNNING indicator light (13, Figure 6-24) shows that the LPAC is in the run mode with the drive motor energized. With the motor contactor (16, Figure 6-26) closed and the LPAC drive motor running, this light normally glows green. This optically enhanced light requires a 120VAC bulb (41, Figure 6-24).

5-2.2.1.6 WARN/FAIL Indicator Light. The WARN/FAIL indicator light (14, Figure 6-24) glows red when the PLC detects that a LPAC condition is not within its default or preset parameter. Normally, this light does not glow. This optically enhanced light requires a 120VAC bulb (41, Figure 6-24).

5-2.2.1.7 Hours Meter. The hours meter (15, Figure 6-24) indicates the total number of hours the LPAC drive motor has been energized. With power applied, the ON/OFF selector switch (9, Figure 6-24) in the ON position and the motor contactor (16, Figure 6-26) closed, the hours meter advances.

5-2.2.1.8 PLC Touchscreen Display. The PLC touchscreen display (19, Figure 6-24) is a 6" flat panel color LCD touchscreen display providing operator interface with the programmable logic controller. The PLC touchscreen display provides the operator with the operational status of the LPAC (refer to Figure 2-4). When the system pressure drops to the default low-pressure limit the touchscreen display informs the operator "COMPRESSOR START-UP ACTIVATED". The touchscreen display sequentially displays LPAC operating data. The touchscreen display shows monitored LPAC sensor readings and compressor status as shown in the LOG DATA screen (refer to Figure 2-4.3). PLC maintenance screens reveal operating data and allow for operator testing of solenoid valves, modify maintenance timers, change pressure range settings and calibrate pressure transducers (refer to Figure 2-4.8 and Paragraph 6-2.2). The touchscreen display (19, Figure 6-24) is a 24VDC-powered device consuming less than 12 watts. The display receives 24VDC from the Power Supply 24VDC Input Control Module (1, Figure 7-2). The touchscreen display (19, Figure 6-24) is a 16-color screen with a 6-inch diagonal view and a 320 x 240 pixel resolution. The touchscreen display (19, Figure 6-24) uses a DIN connector port for loading new screen configurations and a RS-232 serial port for communication with the SLC 5/05 CPU.

5.2.2.2 PLC Controller Assembly. The PLC controller assembly (Figure 6-25) uses replaceable input and output (I/O) cards mounted on a 7-slot chassis (Figure 7-2). The controller assembly is designed to interface with temperature, pressure and level sensors and to directly switch 110VAC or 24VDC to solenoid valves, lights or motor contactor. The controller assembly provides 24VDC to the PLC control panel assembly (1, Figure 6-24) and senses switch positions such as MAN/AUTO, START, STOP and Battle Override. The controller assembly consists of a Power Supply 24VDC Input Control Module (1, Figure 7-2), a SLC 5/05 CPU (2, Figure 7-2), a DC Sink Input Module (3, Figure 7-2), an 8-Channel Analog Input Module (4, Figure 7-2), a Temperature RTD Input Module (5, Figure 7-2), an Output Module-Relay Contacts and Solenoid Valves (6, Figure 7-2), a second Output Module-Relay Contacts, Motor Contactor and Lights (6, Figure 7-2) and a Basic Module For RS-232 Emulation (7, Figure 7-2). The controller assembly has two communication ports. The first is a serial port used to communicate to the PLC touchscreen display. The second is an Ethernet 10 Base T port that can be integrated into any Ethernet network.

5-2.2.2.1 Power Supply Transformer. 110VAC is introduced into the PLC from the HVE via the ON/OFF selector switch (9, Figure 6-24). When placed in the ON position, 110VAC is routed to the primary coil of the PLC power supply transformer (6, Figure 6-25). The power supply secondary coil outputs regulated 24VDC that is distributed to the PLC control panel assembly (1, Figure 6-24) and the PLC power supply 24VDC input control module (1, Figure 7-2). Providing circuit protection for the power supply transformer (6, Figure 6-25) and the PLC control panel assembly (1, Figure 6-24) is Fuse F1 (refer to FO-3 for circuit details and 7, Figure 6-25). Fuse F1 is mounted in a fuse block (11, Figure 6-25). Three terminal blocks (14, Figure 6-25) provide connection points for indicators and controls.

5-2.2.2.2 Power Supply 24VDC Input Control Module. The PLC power supply 24VDC input control module then

distributes 24VDC to the SLC 5/05 CPU (1 and 2, Figure 7-2) and each I/O card on the controller assembly chassis. The power supply has an LED that indicates proper power supply, enabling the operator to tell at a glance if the power supply is operating properly. The power supply is also designed to withstand brief power loses without affecting the operation of the system.

5-2.2.2.3 SLC 5/05 CPU. Next to the power supply module on the controller assembly chassis is the SLC 5/05 CPU (2, Figure 7-2). The CPU is the "brains" of the controller assembly having 16K of flash memory for program storage and data files containing alarm totals, limited data logging, control set points and operating history. The flash memory contains a battery backup as well as an EPROM backup in case the program or data files become corrupted. The CPU has two communication ports. The first is the RS-232 serial port. This port is used as an operator interface/programming port communicating with the touchscreen display on the control panel assembly. Operator commands are directly input into the SLC 5/05 CPU (2, Figure 7-2) via the touchscreen display (19, Figure 6-24), as well as providing the operator with direct system status. The second port is the RJ45 Ethernet 10 Base T port that provides a means of connecting to an Ethernet network such as ICAS that can collect data from the PLC. The SLC 5/05 CPU (2, Figure 7-2) can be programmed with its own IP (Internet Protocol) address or set up to request an address through a server. On the face of the SLC 5/05 CPU (2, Figure 7-2) are various indicating lights. When the LPAC is running the "RUN" light located in the top upper left-hand corner should be glowing green. If the PLC monitors a fault, the "FLT" indicator will glow red. The "RS232" indicator "blinks" green as long as the PLC control panel assembly (1, Figure 6-24) and CPU are communicating.

5-2.2.2.4 S1 DC Sink Input Module. The next module in the controller assembly is the blue S1 DC Sink Input Module (3, Figure 7-2). This input card is a 16-channel card that senses the position of switches and separator tank water-level sensors in the compressor system. This input card receives signals from the various low and high-limit water level sensors, the START pushbutton switch (11, Figure 6-24), the STOP/RESET pushbutton switch (12, Figure 6-24), the MAN/AUTO selector switch (10, Figure 6-24), Battle Override Switch (Figure 6-27), Main Contactor status, Ship Remote ON/OFF switch and the Back Up Air Temp switch.

5-2.2.2.5 S2 8-Channel Analog Input Module. The next module in the controller assembly is the green S2 8-Channel Analog Input Module (4, Figure 7-2) that monitors signals from the pressure sensors. This input card receives signals from the various pressure sensors in the 4-20 ma range. This card monitors the injection water pressure sensor, the discharge air pressure sensor, and the shipboard air pressure sensor.

5-2.2.2.6 S3 Temperature RTD Input Module. This green input module monitors temperature sensors. The S3 Temperature RTD Input Module (5, Figure 7-2) is an 8-channel analog module that receives RTD (resistive temperature device) signals from the various temperature sensors, checking that they are within safe parameters. This card monitors the cooling water out, the cooling water inlet, the discharge air temperature, the injection water temperature and the back up air temperature switch.

5-2.2.2.7 S4 Relay Contact Valves Output Module. The next module on the controller assembly chassis is the orange S4 Relay Contact Valves Output Module (6, Figure 7-2). This 8-channel, isolated relay output card is used to switch both legs of four, 110VAC solenoid valves. This output card switches the blowdown, the tank drain, and the make up and shut off solenoid valves.

5-2.2.2.8 S5 Relay Contact Motor/Lights Output Module. This output module is also an 8-channel, isolated relay output card. The orange S5 Relay Contact Motor/Lights Output Module (6, Figure 7-2) is used to provide 110VAC to the motor contactor (16, Figure 6-26) coil, controlling the starting and stopping of the LPAC. This output card supplies 110VAC to the MOTOR RUNNING and WARN/FAIL indicator lights (13 and 14, Figure 6-24) on the PLC control panel assembly (1, Figure 6-24) and the hours meter (15, Figure 6-24). This output card also provides two dry contacts for shipboard interface-power ON and summary fault.

5-2.2.2.9 S6 Basic Module for RS-232 Emulation. The last module on the controller assembly chassis is the green S6 Basic Module for RS-232 Emulation (7, Figure 7-2).

5-3. DETECTION OF PROBLEMS

The operator should first notice any indication of trouble while the low-pressure air compressor (LPAC) is operating in normal service. During operation, the programmable logic controller (PLC) continuously checks on LPAC operation, comparing it with stored default values. When LPAC operation is outside the stored default limits, the PLC displays a fault message, to alert the operator. In normal mode of operation, if the PLC detects a problem that can cause damage to the LPAC, it will shutdown the LPAC displaying a fatal fault message. In the battle override mode, the operator takes control of the LPAC with the PLC still displaying fault messages. PLC fault messages will normally be the first operator indication of a LPAC malfunction. The LPAC operator should stay alert for unusual noises, excessive vibration, as well as signs of air or liquid leaks.

5-3.1 Troubleshooting Overview. For the most part, when troubleshooting the compressor management system (CMS), standard mechanics hand tools and volt/ohmmeters will prove to be essential for repairing and maintaining the CMS. Refer to Paragraph 6-1.4 for a list of recommended tools for troubleshooting, maintenance and repair. As previously stated, pay particular attention to PLC fault messages, which will normally be the first operator indication of a LPAC malfunction (refer to Table 5-1). As a troubleshooting aid, refer to the trouble isolation and testing procedures outlined in Section 5-4 as well as the information contained in Table 5-1. Upon completion of component troubleshooting and isolation, refer to Chapter 6 for assembly, sub-assembly and component removal, repair and replacement.

5-3.2 Troubleshooting Guidelines. When troubleshooting pay attention to the following:

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

NOTE

Disassemble electrical enclosure only to point necessary to replace defective part or complete desired inspection. Reassemble from that point by reversing the steps already taken.

a) Under no circumstances shall repair or adjustment of energized or pressurized equipment be attempted alone. The immediate presence of someone capable of rendering aid is required.
b) Electrical potential of 440 volts alternating current (VAC) is present in the HVE of the LPAC. Ensure that power is disconnected before making any repairs. Take special precautions to prevent applying power any time maintenance is in progress. Before making adjustments to energized equipment, be sure to protect against grounding.
c) Make sure test equipment is in good condition. If a test meter must be held, ground the case of the meter before starting measurement. Do not touch live equipment or personnel working on live equipment while holding a test meter. Some types of measuring devices should not be grounded; these devices should not be held when taking measurements.
d) An injury, no matter how slight, shall never go unattended. Always obtain first aid or medical attention immediately.
e) Personnel working with or near high voltage shall be familiar with approved methods of resuscitation. Should someone be injured and stop breathing, resuscitation shall be initiated immediately. A delay could cost the victim his life.
f) All electrical components associated with this system/equipment shall be installed and grounded IAW applicable Navy regulations and approved shipboard practices.
g) Precautions set forth in Naval Ships' Technical Manual (NSTM), chapters 300, 302, 310 and 320, shall be observed with respect to electrical equipment and circuits.
h) All circuits not known to be dead must be considered live and dangerous at all times.
i) When working near electricity, do not use metal rules, flashlights, metallic pencils, or any other objects having exposed conducting material.
j) Do not make any unauthorized alterations to equipment or components.
k) When connecting a meter to terminals for measurement, use range higher than expected voltage.
l) Before operating equipment or performing any test or measurements, ensure that frames of all motors and starter panels are securely grounded.
m) When checking for voltage, ensure power is applied and ON. Set voltmeter to correct voltage range (i. e. set voltmeter to 230VAC to measure 220VAC).
n) Red lead on voltmeter should be attached to positive and positive terminals or wires when making voltage checks. The black terminal should be used for negative connection and voltage checks.
o) When checking for continuity, ensure power is OFF. Electrical components such as fuses, switches and wires can all be checked for resistance. Ensure ohmmeter is set for correct range and connect one lead to end of fuse or wire and the other lead to opposing end. If open (no continuity), the wire or fuse has failed and requires replacement.
p) When installing replacement fuses ensure fuse has continuity and is of same rating as fuse being replaced. Ensure replacement wiring is of same gauge as original.

q) Visually check all connections, terminal boards, fuses and components for discoloration, burn marks or signs of overheating.
r) With main power source to LPAC turned OFF and OUT-OF-SERVICE tag installed, ensure all wire interconnection points are tight. Pay particular attention to 440-volt 3-phase AC connection points on motor contactor (16, Figure 6-26) and overload relay (15, Figure 6-26). Ensure interconnection points are tight using flat-blade, Phillips head screwdriver and nut driver.
s) If the functionality of any component is questionable, replace component then cables or wiring, etc.
t) If the functionality of any of the PLC control modules (refer to Figure 7-2) is questionable, replace module.
u) Replace failed components rather than attempting repairs. Replace component that is in question first then troubleshoot internal/external components if replacement fails to solve problem.
v) Refer to Section 6-5 for work area, handling, tools, cleaning and inspection procedures. Refer to this Section for common repair procedures, water management system repair as well as replacement procedures.
w) When installing replacement components, ensure they are tight and secure without over tightening.

5-4. TROUBLE ISOLATION AND TESTING

5-4.1 Initial Analysis of Problem. Should a problem be detected, maintenance personnel should use the procedures in this section to isolate the problem. After the malfunction has been isolated, it should be referred to maintenance personnel for additional analysis and repair.

5-4.2 Fault Determination. A determination must be made as to whether a problem is associated with the LPAC mechanical components or the programmable logic controller (PLC). As a general rule, a PLC failure will cause multiple fault codes (i.e.-multiple water level or temperature faults). LPAC failures will usually be restricted to a single monitor point fault code. LPAC failures can usually be isolated to a repairable or replaceable component. PLC failures usually require the operator to perform additional isolation steps. This section covers trouble isolation and testing of high voltage enclosure (HVE), PLC and system-wide components and failure analysis.

5-4.3 PLC Failure-Internal Component Isolation. (Refer to FO-3 for circuit details.) Whenever the ON/OFF selector switch (5, Figure 2-1) is positioned from OFF to ON (with shipboard power applied), The PLC should light up and go through an initialization cycle. It is important that the PLC touchscreen display (19, Figure 6-24) is securely fastened to the control panel assembly (1, Figure 6-24) after any check or repair. The display panel underside contains an EMI gasket. If the display panel is not tightly secured, it may give a false indication that it has failed. The display panel should always be checked to ensure that it is properly closed when troubleshooting a PLC display panel problem. If the PLC fails to light up and energize the following trouble isolation steps must be performed to determine if an internal component of the PLC or HVE has failed:

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

NOTE

Disassemble electrical enclosure only to point necessary to replace defective part or complete desired inspection. Reassemble from that point by reversing the steps already taken.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.
b) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.
c) Set ON/OFF selector switch (9, Figure 6-24) to OFF.
d) When problem has been corrected, reconnect all disconnected components then close and secure HVE front panel.

5-4.3.1 HVE Component Failure Isolation. (Refer to Figure 6-26 and FO-3 for circuit details.)

a) Perform steps a through c under Paragraph 5-4.3.

b) Using flat-blade screwdriver or nut driver release fasteners and drop HVE front panel.
c) Visually check all connections, terminal boards, fuses and components for discoloration, burn marks or signs of overheating. Use standard shop practices to repair any defects found.
d) Ensure all wire interconnection points are tight using flat-blade, Phillips head screwdriver and nut driver. Pay particular attention to 440-volt 3-phase AC connection points on motor contactor (16) and overload relay (15).
e) Remove OUT-OF-SERVICE tag and restore main power to LPAC.
f) With power applied, check for 440 VAC at TR1 (refer to FO-3). With voltmeter red (positive) lead on L1 and black (negative) lead on ground connection check for 220VAC. Check for 220VAC between L2 and ground connection.

5-4.3.1.1 440-Volt 3-Phase AC Input Fuse F1 Trouble Isolation. (Refer to Figure 6-26 and FO-3 for circuit details.) If the PLC fails to light up and energize after steps in Paragraph 5-4.3.1 have been performed and 440 VAC 3-phase AC power is applied to the HVE, proceed as follows:

a) Check fuse F1 (28) for continuity by connecting ohmmeter leads on each end of fuse. If ohmmeter shows no continuity, the fuse is "open". If found open, replace with a known good fuse of the same rating and retry PLC.
b) If PLC operates normally, return to Paragraph 5-4.3, step d. above.
c) If replacement fuse opens as soon as power is applied, but before drive motor attempts to start, the failure is: power conditioner transformer (1), electrical arrestor (12) RV4, motor contactor (16) or circuit wiring. Isolate as follows:
    1) Refer to FO-3, for circuit details. Then, disconnect suspected components one at a time. Install new fuse and retry PLC after each disconnection. When PLC can be started without fuse F1 opening, the last component disconnected is defective. Replace that component IAW Paragraph 6-7.2.1 and return to Paragraph 5-4.3, step d.

d) If replacement fuse opens only when drive motor attempts to start, the failure is: drive motor, motor contactor (16), overload relay (15), electrical arrestors (12) RV1, RV2, RV3 or drive motor circuit wiring. Refer to FO-3 for circuit details. Isolate as follows:
    1) Disconnect electrical arrestors RV1 through RV3 one at a time. Install a new fuse and retry PLC after each disconnection. If drive motor starts without fuse F1 opening, the last arrestor disconnected is defective. Replace that arrestor IAW 6-7.2.1 and return to Paragraph 5-4.3, step d.
    2) Disconnect drive motor at overload relay (15) terminals T1 and T3. Install good fuse and retry PLC. If replacement fuse does not open, drive motor is drawing excessive amperage and the overload relay (15) is defective. Use standard shop practices to test drive motor. Replace overload relay IAW Paragraph 6-7.2.1 and return to Paragraph 5-4.3, step d.
    3) Reconnect drive motor and disconnect overload relay (15). Install good fuse and retry PLC. If replacement fuse does not open, overload relay is defective. Replace overload relay IAW Paragraph 6-7.2.1 and return to Paragraph 5-4.3, step d.
    4) Reconnect overload relay (15) and disconnect motor contactor (16) terminals L1 and L3. Install good fuse and retry PLC. If replacement fuse does not open, main contactor is defective. Replace IAW Paragraph 6-7.2.1 and return to Paragraph 5-4.3, step d.

5-4.3.1.2 110VAC Output Fuse F3 Trouble Isolation. (Refer to Figure 6-26 and FO-3 for circuit details.) The PLC fails to light up and energize after steps in Paragraph 5-4.3.1 have been performed. 440VAC 3-phase AC power is applied to the HVE, fuse F1 (28) checks good and battle override switch (17) is OFF and inoperable, proceed as follows:

a) Check fuse F3 (29). If found open, replace with a known good fuse of the same rating and retry PLC.
b) If PLC operates normally, return to Paragraph 5-4.3, step d.
c) If replacement fuse opens, either one of the 110VAC components has failed or the 110VAC circuit wiring is defective. Isolate the fault as follows:
    1) Disconnect 110VAC circuit components one at a time. Install new fuse and retry PLC after each disconnection. When

PLC operates normally without fuse F3 opening, the last component disconnected is defective. Replace that component IAW Paragraph 6-7.2.1 and return to Paragraph 5-4.3, step d.

5-4.3.1.3 Battle Override Switch Failure. (Refer to Figure 6-27 and FO-3 for circuit details.) If the PLC fails to light up and energize after steps in Paragraphs 5-4.3.1.1 and 5-4.3.1.2 have been performed, proceed as follows:

a) Remove locking attachment (6) from battle override selector switch (4) on HVE front panel.

b) Position battle override selector switch (4) to ON.

c) Refer to HVE wiring schematic FO-3. Check for 110VAC input by connecting voltmeter between 2SW1 contacts 3A and 3B and between contacts 4C and 4D, then contacts 4E and 4F.

d) If voltmeter reads 110VAC at these contacts check other side of switch by connecting voltmeter between contacts 4A and 4B and contacts 3C and 3D, then contacts 3E and 3F. If 110VAC is not present at these contact points battle override switch (17, Figure 6-26) has failed or wiring is damaged.

e) Replace battle override switch (17, Figure 6-26) IAW Paragraph 6-7.2.1, position battle override selector switch (4) to OFF and install locking attachment (6).

f) Return to Paragraph 5-4.3, step d.

5-4.3.2 PLC Component Trouble Isolation. (Refer to Figure 6-24 and FO-2, for circuit details.)

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

NOTE

Attach wrist ground strap or equivalent prior to handling ESD items.

b) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.

c) Set ON/OFF selector switch (9, Figure 6-24) to OFF

d) When problem has been corrected, reconnect all disconnected components then reassemble and secure PLC front cover (6, Figure 6-24) and/or control panel assembly (1, Figure 6-24).

5-4.3.2.1 ON/OFF Selector Switch Trouble Isolation. (Refer to Figure 6-24 and FO-2, for circuit details.) If the PLC fails to light and energize after performing steps in Paragraphs 5-4.3.1 through 5-4.3.1.3 proceed as follows:

a) Using 1/8" Allen wrench remove eighteen button head bolts (2) and eighteen washers (3).

b) Lift up on control panel assembly (1) and gently flip it on its back.

c) Restore main power and set ON/OFF selector switch (9) to ON.

d) Check for 110VAC input at SW1 by connecting voltmeter between contacts 4A and 4B. If voltmeter reads 110VAC at these contacts check other side of switch by connecting voltmeter between contacts 3A and 3B. If 110VAC is not present at these contact [redacted] has failed or its

Global comment. Change all "button [redacted] head bolts" to "button head screws".

e) Replace ON/OFF selector switch (9) IAW Paragraph 6-7.1.1 and retry PLC.

f) If PLC operates normally, return to Paragraph 5-4.3.2, step d.

5-4.3.2.2 24VDC Power Supply Trouble Isolation. (Refer to Figure 6-25 and FO-2, for circuit details.) If the PLC fails to light and energize after performing steps in Paragraph 5-4.3.2.1 proceed as follows:

a) Perform steps a through c under Paragraph 5-4.3.2.

b) Remove thirty button head bolts (2, Figure 6-24) and washers (3, Figure 6-24) securing front cover and gasket (6 and 7, Figure 6-24).

c) Visually check all connections, terminal boards, fuses and components for discoloration, burn marks or signs of overheating. Use standard shop practices to repair any defects found.

d) Check fuse F1 (7). If open, replace with known good fuse of same rating and retry PLC.

e) Restore main power and position ON/OFF selector switch (9, Figure 6-24) to ON.

f) If PLC operates normally, return to Paragraph 5-4.3.2, step d. If PLC does not operate, go on to next step.

g) If replacement fuse opens as soon as power is applied replace power supply transformer IAW Paragraph 6-7.1.3.

h) If PLC operates normally, return to Paragraph 5-4.3.2, step d. If PLC does not operate, go on to next step.

NOTE

To aid in PLC power supply troubleshooting, an access cover (39, Figure 6-24) and access cover gasket (40, Figure 6-24) can be removed by removing six bolts (2, Figure 6-24) and six washers (3, Figure 6-24). With access cover removed and power applied, the power light on the PLC power supply can be observed to see if it is glowing red.

i) Remove PLC mounting assembly IAW Paragraph 6-7.1.2 and open PLC power supply 24VDC input module (10) door by pushing up on tab in lower right-hand corner of door.

j) Check for 24VDC by connecting voltmeter between +24 VDC and DC NEUT terminals on PLC power supply input module (10).

k) If 24VDC is measured between terminals +24 VDC and DC NEUT and the power light on the PLC power supply 24VDC input module (10) is not glowing red the module has failed.

l) Replace PLC power supply 24VDC input module (10) IAW Paragraph 6-7.1.2 and retry PLC.

m) If PLC operates normally, return to Paragraph 5-4.3.2.

5-4.3.2.3 Control Panel Assembly Trouble Isolation.
(Refer to Figure 6-24 and FO-2, for circuit details.) If the PLC fails to light and energize after performing the steps in Paragraph 5-4.3.2.2 proceed as follows:

a) Perform steps a through c under Paragraph 5-4.3.2.

b) Using 1/8" Allen wrench remove eighteen button head bolts (2) and eighteen washers (3) securing control panel assembly (1).

c) Remove control panel assembly (1) and control panel gasket (4) and gently flip control panel assembly (1) on its back.

d) Remove OUT-OF-SERVICE tag and restore main power to PLC.

e) When problem has been corrected, reconnect all disconnected components then secure control panel assembly (1) by reversing steps c and b above.

5-4.3.2.3.1 PLC Touchscreen Display Trouble Isolation.
(Refer to Figure 6-24 and FO-2, for circuit details.)

a) Perform steps a through d under Paragraph 5-4.3.2.3 above.

b) Connect voltmeter between contacts +24VDC (DP1/24POS) and –24VDC (DP1/24NEG) on right hand side of PLC touchscreen display (19).

c) If 24VDC is present between contacts and PLC touchscreen display (19) fails to light and energize replace PLC touchscreen display (19) IAW Paragraph 6-7.1.1.

d) If PLC operates normally, return to Paragraph 5-4.3.2.3 step e.

5-4.3.2.3.2 START Pushbutton Switch Trouble Isolation.
(Refer to Figure 6-24 and FO-2, for circuit details.)

a) Perform steps a through d under Paragraph 5-4.3.2.3.

b) Check for 24VDC by connecting voltmeter between contacts 4 and 3 on START pushbutton switch (11).

c) If 24VDC is present between contacts and PLC touchscreen display (19) fails to light and energize when START pushbutton switch (11) is depressed, replace START pushbutton switch (11) IAW Paragraph 6-7.1.1.

d) If PLC operates normally, return to Paragraph 5-4.3.2.3, step e.

5-4.3.2.3.3 MAN/AUTO Selector Switch Trouble Isolation. (Refer to Figure 6-24 and FO-2, for circuit details.)

a) Perform steps a through d under Paragraph 5-4.3.2.3.

b) With MAN/AUTO selector switch (10) in AUTO position check for 24VDC by connecting voltmeter between contacts 1 and 2.

c) If 24VDC is present between contacts and PLC touchscreen display (19) fails to light and energize when MAN/AUTO selector switch (10) is positioned to AUTO, replace MAN/AUTO selector switch (10) IAW Paragraph 6-7.1.1.

d) With MAN/AUTO selector switch (10) in MAN position check for 24VDC by connecting voltmeter between contacts 3 and 4.

e) If 24VDC is present between contacts and PLC touchscreen display (19) fails to light and energize when MAN/AUTO selector switch (10) is positioned to MAN, replace MAN/AUTO selector switch (10) IAW Paragraph 6-7.1.1.

f) If PLC operates normally, return to Paragraph 5-4.3.2.3 step e.

5-4.3.2.3.4 STOP/RESET Pushbutton Switch Trouble Isolation. (Refer to Figure 6-24 and FO-2, for circuit details.)

a) Perform steps a through d under Paragraph 5-4.3.2.3.

b) Check for 24VDC by connecting voltmeter between contacts 1 and 2 on STOP/RESET pushbutton switch (12).

c) If 24VDC is present between contacts and PLC touchscreen display (19) fails to light and energize when STOP/RESET pushbutton switch (12) is depressed, replace STOP/RESET pushbutton switch (12) IAW Paragraph 6-7.1.1.

d) If PLC operates normally, return to Paragraph 5-4.3.2.3 step e.

5-4.3.2.3.5 Hours Meter Trouble Isolation. (Refer to Figure 6-24 and FO-2, for circuit details.)

a) Perform steps a through d under Paragraph 5-4.3.2.3.

b) Check for 110VAC by connecting voltmeter between the two wires HM1 and HM2 (HM1 NEG) going to the hours meter (15).

c) If 110VAC is present between contacts replace hours meter (15) IAW Paragraph 6-7.1.1.

d) If PLC and hours meter (15) operate normally, return to Paragraph 5-4.3.2.3, step e.

5-4.3.2.3.6 MOTOR RUNNING and WARN/FAIL Lights Trouble Isolation. (Refer to Figure 6-24 and FO-2, for circuit details.)

a) Perform steps a through d under Paragraph 5-4.3.2.3.

b) Check for 110VAC by connecting voltmeter between the two wires X1 and X2 going to the MOTOR RUNNING (13) bulb.

c) If 110VAC is present between contacts and bulb is not glowing green, replace MOTOR RUNNING bulb (41) IAW Paragraph 6-7.1.1.

d) Check for 110VAC by connecting voltmeter between the wires X1 and X2 going to the WARN/FAIL bulb (41).

e) If 110VAC is present between contacts and bulb is not glowing red, replace WARN/FAIL bulb (41) IAW Paragraph 6-7.1.1.

f) If PLC and MOTOR RUNNING bulb (41) and/or WARN/FAIL bulb (41) operate normally, return to Paragraph 5-4.3.2.3, step e.

5-4.4 PLC Failure-External Component Isolation.
(Refer to Figure 6-24 and FO-2 for circuit details.) The programmable logic controller (PLC) is designed to operate in the automatic or manual mode. All safety functions such as pressures, temperatures and tank status are monitored. Pressure is applied to all transducers and temperatures are monitored. The PLC then starts the low-pressure air compressor (LPAC) by "pulling in" the motor contactor, closing the circuit. In the automatic mode, the PLC begins start-up when it senses that system pressure is below the default low-pressure range limit. When system pressure drops to default low pressure limit the following occurs:

a) PLC touchscreen display (19) displays "COMPRESSOR START-UP ACTIVATED".

b) Make-up, unloader and shut-off solenoids energize.

c) Motor contactor closure delay timer starts.

d) Motor contactor closes on completion of delay.

e) Make-up solenoid de-energizes.

f) PLC touchscreen display (19) reads "NORMAL START-UP COMPLETED".

g) MOTOR RUNNING indicator light (13) glows green.

h) Hours meter (15) starts to run.

i) PLC touchscreen display (19) begins displaying LPAC operating data.

j) LPAC cycles ON and OFF as default high and low system pressure limits are sensed by the PLC.

In the manual mode, the PLC will only begin start-up when it senses that system pressure is below the default low-pressure range limit and the START pushbutton switch (11) has been pressed. If the START pushbutton switch (11) has been pressed while system pressure is at the default high-pressure range limit the PLC will abort LPAC start-up and read "NO START: AT HI PRESSURE LIMIT" for 5 seconds. The PLC touchscreen display (19) then reads: "COMPRESSOR READY FOR START". Then, in the manual mode, the PLC checks for any fatal faults and if none are detected goes through the same sequence of events (steps b through i listed above) as in the automatic mode.

5-4.4.1 Pressure Transducer Trouble Isolation. (Refer to FO-2 for circuit details.) The PLC checks to ensure that no fatal (LPAC damaging) conditions exist. If a fatal condition is detected, the PLC will abort LPAC start-up

and will display a fatal fault message describing fault condition (refer to Figure 2-4.19). The compressor management system (CMS) has three pressure transducers (refer to Figure 1-2) the injection water pressure transducer, the discharge air pressure transducer and the shipboard air pressure transducer. The J4 cable harness (refer to FO-2) is attached to the three pressure transducers allowing the S2 8-channel analog input module (4, Figure 7-2) on the PLC controller assembly (refer to Figure 6-25) to read 4-20 ma input pressure signals from the pressure transducers. These input signals allow the PLC to check for any indication of a blockage or malfunctioning valve in the cooling water closed loop. The PLC also checks that the injection water pressure is not less than 50% of the air discharge pressure. The PLC checks for adequate pressure for bearing lubrication. The PLC checks the discharge air pressure so that it does not get any higher than 135 psig.

5-4.4.1.1 Pressure Transducer Input Failure. Pressure transducer input failure must be analyzed to determine if the failure relates to a single transducer or if all transducers are affected. Failure of a single pressure transducer input is probably the result of a failed pressure transducer or a damaged or defective input cable. Total failure of all pressure transducer inputs indicates a failure of the PLC S2 8-channel analog input module (4, Figure 7-2).

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

5-4.4.1.2 Single Pressure Transducer Failure. (Refer to Figure 6-24 unless otherwise indicated.) If the PLC touchscreen display (19) shows a single pressure transducer fault condition (refer to Figure 2-4.19) the following steps should be taken:

a) Inspect the appropriate pressure transducer cable for damage and proper connection; ensuring it is tight at both high voltage enclosure (HVE) and pressure transducer.

b) With the compressor running, refer to FO-2 and disconnect the transducer cable connector from the failed transducer (refer to Figure 1-2 for pressure transducer location). The cable can be disconnected by unscrewing the knurled portion of the connector cable that connects to the pressure transducer. Disconnect the cable going to another pressure transducer and connect the first transducer cable to this pressure transducer.

c) If the newly connected pressure transducer input functions normally, the original pressure transducer has failed and must be replaced. Replace pressure transducer IAW Paragraph 6-6.17.

d) If the newly connected transducer fails to operate, the transducer cable, including the connector at each end must be checked for continuity. Check for continuity by disconnecting the cable from the pressure transducer and the J4 connector elbow that connects to the outside of the HVE (refer to Figure 1-1). With the cable disconnected and the ohmmeter connected between pin A on the connector elbow and slot A on the pressure transducer end, check for continuity. The meter should show continuity. If ohmmeter does not show continuity, replace cable and connectors. Repeat same procedure for pins B and C.

e) If the pressure transducer cable shows continuity, the pressure transducer failure should be considered a PLC S2 8-channel analog input module (4, Figure 7-2) failure.

5-4.4.1.3 S2 8-Channel Analog Input Module Failure. (Refer to Figure 6-24 and FO-2 for circuit details.) In the event of total pressure transducer input failure proceed as follows:

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (10) to **MAN**.

b) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.

c) Position ON/OFF selector switch (9) to OFF.

d) Using 1/8" Allen wrench remove thirty button head bolts (2) and washers (3) securing front cover (6).

e) Lift off front cover (6) and front cover gasket (7).

f) Disconnect the J4 connector elbow that connects to the outside of the HVE (refer to Figure 1-1) by unscrewing the knurled portion of the elbow that connects directly to the electrical connector (29).

NOTE

Pin A is measured for injection water pressure transducer. Substitute pin C for discharge air pressure transducer and pin K for shipboard air pressure transducer.

g) Connect ohmmeter between pin A on outside of electrical connector (29) and to the connection point of wire 1J4A-TB1/3B on terminal block TB1 "B" (refer to FO-2).

h) Ohmmeter should show continuity. If ohmmeter does not show continuity, replace wire.

i) Reconnect J4 connector elbow to electrical connector (29) by lining up pins and inserting into electrical connector. The J4 connector elbow should go into the electrical connector (29) easily-do not force. Screw knurled portion of J4 connector elbow until it fits snugly on electrical connector (29).

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

j) Restore power to unit.

k) Position ON/OFF selector switch (9) to ON.

l) With voltmeter check for 24VDC by connecting positive lead to terminal connection on terminal block TB0 for wire TB0/8B. Connect ohmmeter negative lead to terminal connection on terminal block TB0 for wire TB0/9B.

m) If voltmeter check measures 24VDC and continuity was measured in step g, replace S2 8-channel analog input module (4, Figure 7-2) IAW Paragraph 6-7.1.2.1.

5-4.4.2 Temperature Transducer Trouble Isolation.

(Refer to FO-2 for circuit details.) The PLC checks to ensure that no fatal (LPAC damaging) conditions exist. If a fatal condition is detected, the PLC will abort LPAC start-up and will display a fatal fault message describing fault condition (refer to Figure 2-4.21). The compressor management system (CMS) has four temperature transducers (refer to Figure 1-2) the cooling water out temperature transducer, the cooling water inlet temperature transducer, the discharge air temperature transducer, the injection water temperature transducer and the back up air temperature transducer. The J3 cable harness (refer to FO-2) is attached to the temperature transducers allowing the S3 temperature RTD input module (5, Figure 7-2) on the PLC controller assembly (refer to Figure 6-25) to read resistive temperature device (RTD) input signals from the temperature transducers. These input signals allow the PLC to check for any indication of the discharge temperature getting too high, that too much heat is being put into the system or that heat is not being removed from the system fast enough. Discharge air temperature is checked by the PLC and the LPAC is shut down if the temperature reaches 135° F. The back up air temperature switch will shut the LPAC down if the temperature reaches 140° F.

5-4.4.2.1 Temperature Transducer Input Failure.

Temperature transducer input failure must be analyzed to determine if the failure relates to a single transducer or if all transducers are affected. Failure of a single temperature transducer input is probably the result of a failed temperature transducer or a damaged or defective input cable. Total failure of all temperature transducer inputs indicates a failure of the PLC S3 temperature RTD input module (5, Figure 7-2).

5-4.4.2.2 Single Temperature Transducer Failure.

(Refer to Figure 6-24 unless otherwise indicated.) If the PLC touchscreen display (19) shows a single temperature transducer fault condition (refer to Figure 2-4.21) the following steps should be taken:

a) Inspect the appropriate temperature transducer cable for damage and proper connection; ensuring it is tight at both high voltage enclosure (HVE) and temperature transducer.

b) With the compressor running, refer to FO-2 and disconnect the transducer cable connector from the failed transducer (refer to Figure 1-2 for temperature transducer location). The cable can be disconnected by unscrewing the knurled portion of the connector cable that connects to the temperature transducer. Disconnect the cable going to another temperature transducer and connect the first transducer cable to this temperature transducer.

c) If the newly connected temperature transducer input functions normally, the original temperature transducer has failed and must be replaced. Replace temperature transducer IAW Paragraph 6-6.21.

d) If the newly connected transducer fails to operate, the transducer cable, including the connector at each end that connects to the outside of the HVE (refer to Figure 1-1), must be checked for continuity. With the cable disconnected and the ohmmeter connected between slot A on the connector elbow and slot A on the temperature transducer end, check for continuity. The meter should show continuity. If ohmmeter does not show continuity, replace cable and connectors. Repeat same procedure for slot B.

e) If the temperature transducer cable shows continuity, the temperature transducer failure should be considered a PLC S3 temperature RTD input module (5, Figure 7-2) failure.

5-4.4.2.3 S3 Temperature RTD Input Module Failure.
(Refer to Figure 6-24 and FO-2 for circuit details.) In the event of total temperature transducer input failure proceed as follows:

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (10) to **MAN**.
b) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.
c) Position ON/OFF selector switch (9) to OFF.
d) Using 1/8" Allen wrench remove thirty button head bolts (2) and washers (3) securing front cover (6).
e) Lift off front cover (6) and front cover gasket (7).
f) Disconnect the J3 connector elbow that connects to the outside of the HVE (refer to Figure 1-1) by unscrewing the knurled portion of the elbow that connects directly to the electrical connector (30).

NOTE

Pin A is measured for cooling water out temperature transducer. Substitute pin C for cooling water inlet temperature transducer, pin E for discharge air temperature transducer, pin G injection water temperature transducer and pin J for back up air temperature switch.

g) Connect ohmmeter between pin A on outside of electrical connector (30) and to the connection point of wire J3A-S3/RTD1 at rtd 1 and then at sn 1 on S3 temperature RTD input module (refer to FO-2) by opening door of module and looking for connection point designated on inside of module door.
h) Ohmmeter should show continuity. If ohmmeter does not show continuity, replace wire.
i) Reconnect J3 connector elbow to electrical connector (30) on outside of HVE by lining up pins and inserting into electrical connector (30). If properly aligned, the J3 connector elbow should go into the electrical connector (30) easily-do not force. Screw knurled portion of J3 connector elbow until it fits snugly on electrical connector (30).

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

j) Restore power to unit.
k) Position ON/OFF selector switch (9) to ON.
l) Check for 24VDC by connecting voltmeter between +24 VDC and DC NEUT terminals on PLC power supply input module (1, Figure 7-2).
m) If wire showed continuity in step g and proper voltage is measured in step l, replace S3 temperature RTD input module (5, Figure 7-2) IAW 6-7.1.2.1.

5-4.4.3 Water Level Switch Trouble Isolation.
(Refer to FO-2 for circuit details.) The PLC checks to ensure that no fatal (LPAC damaging) conditions exist. If a fatal condition is detected, the PLC will abort LPAC start-up and will display a fatal fault message describing fault condition (refer to Figure 2-4.5). The compressor management system (CMS) checks water level switches, ensuring that the water level in the separator tank is at a normal level. If the water level in the separator tank gets too high the air end will flood and water will be injected into the ship's air system. If the water level in the separator tank gets too low the air end will be starved of water and lubrication. High and low-level water switches close (or open as in the case of the high high level switch) shutting down the LPAC should the water level reach a LPAC-damaging level. The J5 cable harness (refer to FO-2) is attached to the various water level switches allowing the S1 DC sink input module (3, Figure 7-2) to read signals from the various water level switches for proper operation.

5-4.4.3.1 Water Level Switch Input Failure. Water level switch input failure must be analyzed to determine if the failure relates to a single water level switch or if all water level switches are affected. Failure of a single water level switch input is probably the result of a failed water level switch or a damaged or defective wire. Total failure of all water level switch inputs indicates a failure of the PLC S1 DC sink input module (3, Figure 7-2).

5-4.4.3.1 Single Water Level Switch Failure.

(Refer to Figure 6-24 and FO-2.) If the PLC touchscreen display (19) shows a single water level fault condition (refer to Figure 2-4.5) the following steps should be taken:

a) Inspect the J5 cable for damage and proper connection; ensuring it is tight at both high voltage enclosure (HVE) and water level switch end.

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

b) Set **MAN/AUTO** selector switch (10) to **MAN**.

c) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.

d) Position ON/OFF selector switch (9) to OFF.

e) If single water level switch failure is indicated, replace water level switch IAW Paragraph 6-6.16.2.

5-4.4.3.2 S1 DC Sink Input Module Failure.

(Refer to Figure 6-24 and FO-2 for circuit details.) In the event of total water level switch input failure proceed as follows:

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (10) to **MAN**.

b) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.

Change to "screws".

N/OFF selector switch (9) to OFF.

d) Using 1/8" Allen wrench remove thirty button head bolts (2) and washers (3) securing front cover (6).

e) Lift off front cover (6) and front cover gasket (7).

f) Disconnect the J5 connector elbow that connects to the outside of the HVE (refer to Figure 1-1) by unscrewing the knurled portion of the elbow that connects directly to the electrical connector (28).

NOTE

Pin B is measured for low low water level switch. Substitute pin E for super high level water switch, pin H for high high water level switch, pin S for high level water switch, pin X for low level water switch and pin G for normal water level switch.

g) Connect ohmmeter between pin B on outside of electrical connector (28) and to the connection point of wire 1J5/B-S1/0 at IN 0 on S1 DC sink input module (refer to FO-) by opening door of module and looking for connection point designated on inside of module door.

h) Ohmmeter should show continuity. If ohmmeter does not show continuity, replace wire.

i) Reconnect J5 connector elbow to electrical connector (28) on outside of HVE by lining up pins and inserting into electrical connector (28). If properly aligned, the J5 connector elbow should go into the electrical connector (28) easily-do not force. Screw knurled portion of J5 connector elbow until it fits snugly on electrical connector (28).

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

j) Restore power to unit.

k) Position ON/OFF selector switch (9) to ON.

l) Check for 24VDC by connecting voltmeter between +24 VDC and DC NEUT terminals on PLC power supply input module (1, Figure 7-2).

m) If wire showed continuity in step g and proper voltage is measured in step l, replace S1 DC sink input module (3, Figure 7-2) IAW Paragraph 6-7.1.2.1.

5-4.4.4. Solenoid Valve Trouble Isolation. (Refer to FO-2 for circuit details.) The PLC checks to ensure that no fatal (LPAC damaging) conditions exist. Input signals are sent to the PLC from the pressure and temperature transducers alerting the PLC to any fatal pressure or temperature conditions. If a fatal condition is detected, the PLC will abort LPAC start-up and display a fatal fault message describing the fault condition. Another indication of solenoid valve failure could be if the PLC indicates that "TANK DRAIN TIME LIMIT EXCEEEDED". The CMS controls the blowdown, the tank drain, and the make up and shut off solenoid valves. The J2 cable harness (refer to FO-2) is attached to the solenoid valves allowing the S4 relay contact valves output module (6, Figure 7-2) to switch both legs of the four 110 VAC solenoid valves.

5-4.4.4.1 Solenoid Valve Failure.

Solenoid valve failure must be analyzed to determine if the failure relates to a single solenoid valve or if all solenoid valves are affected. Failure of a single solenoid valve is probably the result of a failed solenoid valve, loose or damaged wire. Total failure of all solenoid valves indicates a failure of the PLC S4 relay contact valves output module (6, Figure 7-2).

5-4.4.4.2 Single Solenoid Valve Failure. (Refer to figure 6-24 unless otherwise indicated.) If the PLC touchscreen display (19) indicates a single solenoid valve failure the following steps should be taken:

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (10) to **MAN**.

b) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.

c) Position ON/OFF selector switch (9) to OFF.

d) Using flat-blade screwdriver or nut driver release fasteners and drop HVE front panel.

e) If a single solenoid valve fails to function check associated fuse as follows:

1) Blowdown solenoid valve circuit-check fuse F4 (29, Figure 6-26).

2) Tank drain solenoid valve circuit-check fuse F5 (29, Figure 6-26).

3) Make up solenoid valve circuit-check fuse F6 (29, Figure 6-26).

4) Shut off solenoid valve circuit-check fuse F7 (29, Figure 6-26).

f) Identify the fuse (refer to FO-3) associated with the solenoid valve in question and take a continuity check by connecting ohmmeter to both ends of fuse. If ohmmeter shows continuity, fuse is good. If continuity is not indicated, fuse is "open" and must be replaced.

g) If fuse is open, extract existing fuse with fuse extractor and replace with known good fuse of same rating.

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

h) Restore power to unit.

i) Position ON/OFF selector switch (9) to ON.

j) If replacement fuse opens with power applied position **MAN/AUTO** selector switch (10) to **MAN**.

k) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.

l) Position ON/OFF selector switch (9) to OFF.

m) Disconnect H1 cable harness (refer to FO-3) from bottom of HVE by unscrewing knurled portion of elbow that connects to electrical connector (43, Figure 6-26) and install known good fuse of same rating.

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

n) Restore power to unit.

o) Position ON/OFF selector switch (9) to ON.

p) If new fuse opens, problem is with the HVE. Perform troubleshooting steps starting at Paragraph 5-4.3.1.1.

q) If new fuse does not open, check for 110VAC output to solenoid valves by connecting voltmeter between appropriate connection points (refer to FO-3) on S4 relay contact valves output module (6, Figure 7-2).

r) Set **MAN/AUTO** selector switch (10) to **MAN**.

s) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.

t) Position ON/OFF selector switch (9) to OFF.

u) Disconnect the J2 connector elbow that connects to the outside of the HVE (refer to Figure 1-1) by unscrewing the knurled portion of the elbow that connects directly to the electrical connector (31).

NOTE

Pins A and B are measured for blowdown solenoid valve. Pins C and D are measured for the tank drain solenoid valve. Pins E and F are measured for the make up solenoid valve and pins G and H are measured for the shut off solenoid valve.

v) Connect ohmmeter between pin on outside of electrical connector (31) and to the connection point of wire on S4 relay contact valves output module (refer to FO-2) by opening door of module and looking for connection point designated on inside of module door.

w) If solenoid valve wires have continuity and 110VAC output was measured in step q, replace solenoid valve IAW Paragraphs 6-6.15.1 through 6-6.15.3.

x) Reconnect H1 cable assembly to bottom of HVE connector (43, Figure 6-26) on outside of HVE by lining up pins and inserting into electrical connector (43, Figure 6-26). If properly aligned, the H1 connector elbow should go into the electrical connector (43, Figure 6-26) easily-do not force. Screw knurled portion of H1 connector elbow until it fits snugly on electrical connector (43, Figure 6-26).

y) Using flat-blade screwdriver or nut driver, secure HVE door fasteners.

5-4.4.4.3 S4 Relay Contact Valves Output Module Failure. (Refer to Figure 6-24 and FO-2 for circuit details.) In the event of total solenoid valve failure proceed as follows:

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (10) to **MAN**.

b) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.

c) Position ON/OFF selector switch (9) to OFF.

d) Using 1/8" Allen wrench remove thirty button head bolts (2) and washers (3) securing front cover (6).

e) Lift off front cover (6) and front cover gasket (7).

f) Restore power to unit.

g) Position ON/OFF switch (9) to ON.

h) Check for 24VDC by connecting voltmeter between +24 VDC and DC NEUT terminals on PLC power supply input module (1, Figure 7-2).

i) If 24VDC was measured, go to next step. If voltage check revealed no voltage at these points go to Paragraph 5-4.3.2.2.

j) Check for 110VAC by connecting voltmeter between wires SW1/3B-S4/0V and 1J1c-S4/1V by opening door of S4 relay contact valves output module (6, Figure 7-2) and connecting positive lead to 0v and negative lead to 1v as designated on inside of module door.

k) If 110VAC is measured at this point, replace S4 relay contact valves output module (6, Figure 7-2) IAW Paragraph 6-7.1.2.1.

5-4.4.5 Motor Contactor/Overload Relay Trouble Isolation. (Refer to Figure 6-26 and FO-3 for circuit details.) The motor contactor overload relay (15) and motor contactor (16) work in conjunction to switch power to the LPAC drive motor. The motor contactor has a 110VAC coil, when energized, "pulls in" and switches 440, 3-phase VAC to the LPAC drive motor, starting the unit. Anytime the drive motor draws excessive current, resulting in the overload relay (15) sensing too much heat the overload relay (15) de-energizes the motor contactor, shutting down the LPAC. The PLC touchscreen display (19, Figure 6-24) displays a "FATAL STATUS MAIN CONTACTOR FAILURE" (refer to Figure 2-4.7) reading the motor contactor status as open while the LPAC is running. The S5 relay contact motor/lights output module (6, Figure 7-2) provides motor contactor control, connecting to the motor contactor coil at R on the J1 main input/outputs cable harness (refer to FO-3).

5-4.4.5.1 Motor Contactor/Overload Relay Failure. Failure of the motor contactor to stay energized while the LPAC is running must be analyzed to determine if the failure relates to the overload relay (15), motor contactor (16) or the S5 relay contact motor/lights output module (6, Figure 7-2).

5-4.4.5.2 Overload Relay Failure. (Refer to Figure 6-24 unless otherwise indicated.) When the PLC touchscreen display (19) indicates a main contactor failure, the overload relay (15, Figure 6-26) can be reset by pressing the STOP/RESET pushbutton switch (12). If overload relay (15, Figure 6-26) does not reset when STOP/RESET pushbutton switch (12) is pressed refer to FO-3 and proceed as follows:

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (10) to **MAN**.

b) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.

c) Position ON/OFF selector switch (9) to OFF.

d) Using flat-blade screwdriver or nut driver release fasteners and drop HVE front panel.

e) Connect ohmmeter between contacts C3 and C4 (refer to FO-3) on overload relay (15, Figure 6-26)

f) If meter does not show continuity replace overload relay (15, Figure 6-26) IAW Paragraph 6-7.2.1.5.

g) If meter showed continuity go to Paragraph 5-4.3.2.3.3.

5-4.4.5.3 Motor Contactor Failure. (Refer to Figure 6-24 unless otherwise indicated.) If the PLC touchscreen display (19) indicates a main contactor failure and the overload relay (15, Figure 6-26) can be reset and tests good IAW Paragraph 5-4.4.5.2 proceed as follows:

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

a) Set **MAN/AUTO** selector switch (10) to **MAN**.

b) Position ON/OFF selector switch (9) to ON.

c) Using flat-blade screwdriver or nut driver release fasteners and drop HVE front panel.

NOTE

The motor contactor (16, Figure 6-26) is a sealed unit. The entire contactor assembly must be replaced if an internal problem is detected.

d) Check for 220VAC by connecting voltmeter between terminals L1 and L2 (refer to FO-3).

e) Check for 220VAC by connecting voltmeter between terminals L2 and L3 (refer to FO-3).

f) Check motor contactor (16, Figure 6-26) coil for 110VAC by connecting voltmeter between terminals C1 and C2 (refer to FO-3).

g) If 110VAC is not present, proceed to Paragraph 5-4.4.5.4.

h) If 110VAC is present and proper voltage was measured in steps d and e above and motor is not running, the motor contactor (16, Figure 6-26) is defective and must be replaced. Replace motor contactor (16, Figure 6-26) IAW Paragraph 6-7.2.1.3.

5-4.4.5.4 S5 Relay Contact Motor/Lights Output Module Failure. (Refer to Figure 6-24 and FO-2.) The S5 relay contact motor/lights output module (6, Figure 7-2) supplies 110VAC to the motor contactor (16, Figure 6-26) coil, as well as providing 110VAC to the MOTOR RUNNING (13) indicator light, WARN/FAIL (14) indicator light as well as the hours meter (15). In the event that all of these components fail at the same time it is likely that the S5 relay contact motor/lights output module (6, Figure 7-2) has failed. In the event that following troubleshooting for any of these components has not provided the solution, proceed as follows:

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (10) to **MAN**.

b) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.

c) Position ON/OFF selector switch (9) to OFF.

d) Using 1/8" Allen wrench remove thirty button head bolts (2) and washers (3) securing front cover (6).

e) Lift off front cover (6) and front cover gasket (7).

f) Restore power to unit.

g) Position ON/OFF switch (9) to ON.

h) Check for 24VDC by connecting voltmeter between +24 VDC and DC NEUT terminals on PLC power supply input module (1, Figure 7-2).

i) If 24VDC was measured, go to next step. If voltage check revealed no voltage at these points go to Paragraph 5-4.3.2.2.

j) Check for 110VAC output by opening S5 relay contact motor/lights output module (6, Figure 7-2) door and measuring IAW information designated on inside of module door and IAW FO-2. If there is no glowing light on the face of the module and/or no indication of 110VAC output or partial 110VAC output, replace module IAW 6-7.1.2.1.

5-4.4.6 Drive Motor Trouble Isolation. (Refer to Figure 6-26 and FO-3 for circuit details.) The motor contactor overload relay (15) and motor contactor (16) work in conjunction to switch power to the LPAC drive motor. The motor contactor has a 110VAC coil, when energized, "pulls in" and switches 440, 3-phase VAC to the LPAC drive motor, starting the unit. Anytime the drive motor draws excessive current, resulting in the overload relay (15) sensing too much heat the overload relay (15) de-energizes the motor contactor, shutting down the LPAC. The PLC touchscreen display (19, Figure 6-24) displays a "FATAL STATUS MAIN CONTACTOR FAILURE" (refer to Figure 2-4.7) reading the motor contactor status as open while the LPAC is running. The S5 relay contact motor/lights output module (6, Figure 7-2) provides motor contactor control, connecting to the motor contactor coil at R on the J1 main input/outputs cable harness (refer to FO-3).

5-4.4.6.1 Drive Motor Failure. (Refer to Figure 6-24 and FO-3 for circuit details.) If the LPAC will not start, or if the overload relay (15, Figure 6-26) trips or if the LPAC stops suddenly without going through unloaded or drain cycle operation a determination has to be made as to what has failed.

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) If 440, 3-phase VAC has been applied to the LPAC and it will not start proceed as follows:

1) Set **MAN/AUTO** selector switch (10) to **MAN**.
2) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.
3) Position ON/OFF selector switch (9) to OFF.
4) Using flat-blade screwdriver or nut driver release fasteners and drop HVE front panel.
5) Using flat-blade screwdriver remove two screws (7, Figure 6-26) securing terminal cover (8, Figure 6-26) between overload relay (15, Figure 6-26) and motor contactor (16, Figure 6-26). Remove terminal cover (8, Figure 6-26).
6) Visually inspect enclosure for any indication of burnt wires or internal damage.
7) Inspect fuses for any signs of burning or discoloration. If a fuse is burnt proceed to Paragraph 5-4.3.1.1.
8) Restore power to unit.
9) Position ON/OFF switch (9) to ON.
10) Check for 220VAC by connecting voltmeter between T1 and T2 (refer to FO-3) on motor contactor (16, Figure 6-26).
11) Check for 220VAC by connecting voltmeter between T2 and T3 on motor contactor (16, Figure 6-26).
12) If measurements reveal voltage in steps 10 and 11, replace drive motor IAW Paragraph 6-6.6.
13) Set **MAN/AUTO** selector switch (10) to **MAN**.
14) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.
15) Using flat-blade screwdriver install two screws (7, Figure 6-26) securing terminal cover (8, Figure 6-26) between overload relay (15, Figure 6-26) and motor contactor (16, Figure 6-26).
16) Close HVE door and using flat-blade screwdriver or nut driver secure fasteners.

b) If 440, 3-phase VAC has been applied to the LPAC and the LPAC stops suddenly without going through unloaded or drain cycle proceed as follows:

1) Press STOP/RESET pushbutton switch (12).
2) If drive motor tries to start but STOP/RESET pushbutton switch (12) trips, replace drive motor IAW Paragraph 6-6.6.
3) If drive motor does not attempt to start, replace STOP/RESET pushbutton switch (12) IAW Paragraph 6-7.1.1.2.

5-5. WARNING AND FATAL FAULTS

This section contains warning and fatal faults generated by the programmable logic controller (PLC). Warning faults are detected and displayed for items, which by themselves, will not cause mechanical damage to the low-pressure air compressor (LPAC). Warning faults may indicate a trend that will eventually cause a fatal compressor fault. Fatal faults are faults that alert the operator to dangerous and possibly damaging trends to the LPAC. Fatal faults are absolute limits, that will cause an immediate LPAC shutdown with a lockout for compressor restart until the STOP/RESET pushbutton switch (12, Figure 6-24) has been pressed and the fault condition corrected. All warning and fatal faults are discussed in this section.

5-5.1. Level Sensor Warning Faults. The following level sensor warning faults are indications of LPAC operations outside of the normal parameters of operation. Their causes can be as simple as a humidity change in the LPAC space, or more seriously, a blocked drain line, failed solenoid valve or failed tank level sensor.

5-5.1.1 STATUS ERROR HI LEVEL SENSOR. (Refer to Table 5-1.) This warning indicates that the high-level water level switch has failed to operate according to the normal or expected logic patterns. This can be due to the high-level water level switch malfunctioning, causing a drain action that results in the normal water level switch to OPEN. If the high-level water switch is still not OPEN, this would indicate a switch failure. It can also be detected by a rise in water level where the high limit water level switch activates, but the high-level water level switch remains OPEN.

5-5.1.2 STATUS ERROR NORM LEVEL SENSOR. (Refer to Table 5-1.) This warning is the result of the normal level water level switch failing to operate per the expected logic patterns. The PLC detects this condition by matching the normal level input against the low and high water level inputs. A mismatch in input data results in this warning.

5-5.1.3 STATUS ERROR LOW LEVEL SENSOR. (Refer to Table 5-1.) This warning is the result of the low level water level switch failing to operate per the expected logic patterns. The PLC detects this condition by matching the low water level switch input against the low water level switch, the normal water level switch and the high-level water level switch inputs. A mismatch in input data results in this warning.

5-5.1.4 POSSIBLE TANK DRAIN VALVE FAILURE. (Refer to Table 5-1.) This warning indicates that the PLC attempted to perform a separator tank drain with the draining action not resulting in a normal water level sensor indication after the default time period had elapsed. This message is for information only. The PLC has no direct link to the solenoid valve and can only assume that the extended drain action may be due to a solenoid drain valve failure.

5-5.1.5 TANK DRAIN TIME LIMIT EXCEEDED. (Refer to Table 5-1.) This warning only occurs in LPAC RUN mode. It shows that the user-selected time limit for tank draining has been exceeded during the current drain action. This can occur if the solenoid tank drain valve fails to OPEN when energized, if the drain line has been blocked, or if the normal water level switch fails to operate when the water level falls to the correct level.

5-5.1.6 POSSIBLE MAKE-UP VALVE FAILURE. (Refer to Table 5-1.) This warning indicates that the PLC attempted to perform a separator tank fill, but the filling action did not result in a normal water level sensor indication after the default time period had elapsed. This message is for information only. The PLC has no direct link to the make-up solenoid valve and can only assume that that the extended fill action may be due to a make-up solenoid valve failure.

5-5.1.7 TANK FILL TIME LIMIT EXCEEDED. (Refer to Table 5-1.) This warning only occurs in the LPAC RUN mode. It shows that the user-selected low-time limit for tank filling has been exceeded during the current fill action. This can occur if the make-up solenoid valve fails to OPEN when energized, or if the normal water level switch fails to operate when the water level rises to the correct level. This could also be an indication that insufficient time was programmed to allow the tank to fill.

5-5.2 Pressure Limit Warnings. (Refer to Table 5-1.) The pressure warning limits are determined by comparison of the averaged pressure value read from the sensor and the user selected limit value. Since these limits are normally set below the limit of the external pressure relief valves, no compressor damage will result from the limits being reached.

5-5.2.1 INJECTION WATER PRESSURE LOW. (Refer to Table 5-1.) This warning is shown if the injection water pressure has fallen lower than the specified user selected limit while the LPAC is in the START-UP mode. Under operating conditions, this limit would cause a fatal shutdown. This message is self-healing in that it will not be displayed once the injection water pressure returns to above the limit.

5-5.2.2 AIR DISCHARGE PRESSURE LOW. (Refer to Table 5-1.) This warning is shown if the air discharge pressure falls below the user-specified limit. This warning could indicate an open line or a failed back check valve, which is not allowing the pressure to build. This message is self-healing in that it will not be shown once the discharge pressure rises above the limit.

5-5.2.3 SHIPBOARD AIR PRESSURE LOW. (Refer to Table 5-1.) This warning is shown if the shipboard air pressure fails to rise above the user-selected limit after the user-selected pressure rise delay time has ended. This warning could indicate an open line or valve in the shipboard air system. This message is self-healing in that it will not be displayed once the shipboard air pressure rises above the limit.

5-5.3 Temperature Limit Warnings. (Refer to Table 5-1.) The temperature limit warnings are determined by comparison of the averaged temperature value read from the sensor and the user selected limit value. As these limits are normally set below the hardware maximum limits, no LPAC damage will result from the limits being reached.

5-5.3.1 HI SEAWATER DISCHARGE TEMP. (Refer to Table 5-1.) This warning is displayed if the seawater discharge temperature is above the user-selected limit. This warning could indicate a high surrounding temperature in the compartment, or a failure of the LPAC cooling system. This message is self-healing in that it

will not be displayed once the seawater inlet temperature returns to below the limit.

5-5.3.2 HI SEAWATER INLET TEMP. (Refer to Table 5-1.) This warning is shown if the seawater inlet temperature is above the user-selected limit. This warning could indicate a high surrounding temperature in the compartment or a failure of the compressor cooling system. This message is self-healing in that it will not be shown once the seawater inlet temperature returns to below the limit.

5-5.3.3 LO AIR DISCHARGE TEMP. (Refer to Table 5-1.) This warning is shown if the discharge air temperature is below the user-selected limit. This warning is required, as the low pressure air is moisture saturated and this can lead to ice formation in valves and lines. This message is self-healing in that it will not be shown once the discharge air temperature rises above the limit.

5-5.3.4 HIGH AIR DISCHARGE TEMP. (Refer to Table 5-1.) This warning is shown if the discharge air temperature is above the user-selected limit. This warning could indicate a high surrounding temperature in the compartment or failure of the compressor cooling system. This message is self-healing in that it will not be displayed once the discharge air temperature returns to below the limit.

5-5.3.5 LOW INJECTION WATER TEMP. (Refer to Table 5-1.) This warning is shown if the injection water temperature is below the user-selected limit. This is a required warning as low-pressure air is moisture-saturated with low temperatures possibly leading to ice forming in the valves and lines. This message is self-healing in that it will not be displayed once the injection water temperature rises above the limit.

5-5.3.6 HIGH INJECTION WATER TEMP. (Refer to Table 5-1.) This warning is shown if the injection water temperature is above the user-selected limit. This warning could indicate high surrounding air temperature in the compartment, or a failure of the compressor cooling system. This message is self-healing in that it will not be displayed once the injection water temperature returns to below the limit.

5-5.4 Fatal Drain System Faults. Fatal drain system faults are faults that signal dangerous and possibly damaging trends in the LPAC. Any fatal drain fault will cause the LPAC to shutdown until the fatal fault condition has been corrected.

5-5.4.1 FATAL SHUTDOWN HI TANK LIMIT. (Refer to Table 5-1.) In normal mode of operation, this fault should never occur unless the high-level switch or tank drain solenoid has failed. This fatal message indicates that the separator tank has accumulated enough moisture to raise the float to the high-limit switch setting. This message is not self-healing, requiring user intervention for it to be removed and not displayed.

5-5.4.2 FATAL SHUTDOWN LO TANK LIMIT. (Refer to Table 5-1.) In normal mode of operation, this fault should never occur unless the high-level switch or tank drain solenoid has failed. This message is not self-healing, requiring user intervention for it to be removed and not displayed.

5-5.4.3 FATAL SHUTDOWN HI TANK SENSOR. (Refer to Table 5-1.) This fatal message is shown if one of the high-limit switches has failed. One high-limit switch is normally open, the other is normally closed. This fault occurs when the PLC detects that both switches are either OPEN or CLOSED. This message is not self-healing, requiring user intervention for it to be removed and not displayed.

5-5.4.4 FATAL STATUS LO LIMIT SENSOR. (Refer to Table 5-1.) This fatal message is shown if the water level rises to a high level without detection by the lo limit water level switch. Indicates a defective lo limit water level switch. In normal operation, the lo limit water level switch closes when water rises to its level. This message is not self-healing, requiring user intervention for it to be removed and not displayed.

5-5.5 Fatal Pressure Faults. Fatal pressure faults are faults that signal dangerous and possibly damaging trends in the LPAC. Any fatal pressure fault will cause the LPAC to shutdown until the fatal fault condition has been corrected.

5-5.5.1 FATAL LO INJ WATER PRESSURE. (Refer to Table 5-1.) This fatal message is shown if the injection water pressure falls below the user-selected limit. This could indicate a restriction in the water loop, causing a shutdown due possibly to a low tank level. This message is not self-healing, requiring user intervention for it to be removed and not displayed.

5-5.5.2 FATAL HI DISCHARGE AIR PRESSURE. (Refer to Table 5-1.) This fatal message is shown if the injection water pressure falls below the user-selected limit. A faulty back check valve or blocked discharge

line could cause this shutdown. This message is not self-healing, requiring user intervention to be removed.

5-5.5.3 FATAL HI AIR DISCHARGE TEMP. (Refer to Table 5-1.) This fatal message is shown if the discharge air temperature is above the user-selected limit. This fatal message causes LPAC shutdown, protecting valves and diaphragms from premature wear due to high temperature. This message is not self-healing, requiring user intervention to be removed.

5-5.5.4 FATAL ACTIVE DISCHARGE TEMP SWITCH. (Refer to Table 5-1.) Under normal circumstances this fatal message should not be seen. If this fatal message is shown, the backup discharge air temperature switch has activated, indicating the discharge air pressure transducer or connecting cable has failed or shorted. This fatal message causes LPAC shutdown, protecting valves and diaphragms from premature wear due to high temperature. This message is not self-healing, requiring user intervention for it to be removed and not displayed.

5-5.6 Fatal Hardware Faults. Fatal hardware faults are faults that signal dangerous and possibly damaging trends in the LPAC. Any fatal hardware fault will cause the LPAC to shutdown until the fatal fault condition has been corrected.

5-5.6.1 FATAL STATUS MAIN CONTACTOR. (Refer to Table 5-1.) This fatal message is shown if the main contactor opens while the LPAC is running. Failure of the main contactor to stay closed while the LPAC is running could indicate that the overload relay has opened due to too much heat being sensed, failure of the S5 relay contact motor/lights output module or failure of the motor contactor itself. This message is not self-healing, requiring user intervention for it to be removed and not displayed.

5-5.6.2 FATAL AUTO/MANUAL SWITCH INPUT. (Refer to Table 5-1.) This fatal message is shown if the MAN/AUTO selector switch (10, Figure 6-24) has failed. This switch has two inputs, and only one may be high at one time. This message indicates that either both inputs are high or both inputs are low. This message is not self-healing, requiring user intervention for it to be removed and not displayed.

5-5.6.3 BATTLE OVERRIDE ACTIVE. (Refer to Table 5-1.) This fatal message is shown if the battle override switch (17, Figure 6-26) on the HVE is positioned to ON. In this mode, the PLC goes into a monitor only maintenance mode. No action will be taken by the PLC of any detected faults. This message can only be removed by positioning the battle override switch (17, Figure 6-26) to OFF.

5-5.7 Power Supply Faults. There are no power supply fault messages. Failure of the ON/OFF selector switch (9, Figure 6-24), the PLC power supply transformer (6, Figure 6-25) or the PLC power supply 24VDC input control module (1, Figure 7-2) will result in no power going to the PLC control panel assembly (1, Figure 6-24) and the PLC touchscreen display (16, Figure 6-24).

Table 5-1. CMS and Electrical Components Troubleshooting Chart

SYMPTOM	PROBABLE CAUSE	REMEDY
1. PLC does not light up, touchscreen display (19, Figure 6-24) blank.	1. No power to LPAC.	1. Turn-on main power supply to LPAC.
	2. CMS set for manual operation.	1. Position MAN/AUTO selector switch (10, Figure 6-24) to AUTO.
	3. CMS power not turned ON.	1. Position ON/OFF selector switch (9, Figure 6-24) to ON.
	4. Fuse has opened.	1. Test fuses IAW Paragraphs 5-4.3.1.1 and
	5. ON/OFF selector switch (9, Figure 6-24) has failed.	Change referenced paragraph to "6-7.1.1.2". 1. Test ON/OFF selector switch (9, Figure 6-24) IAW Paragraph 5-4.3.2.1. If switch is found to be defective, replace IAW Paragraph 6-7.1.1.
		WARNING Voltages dangerous to life exist when equipment is open and energized. Do not work alone.
	6. PLC touchscreen display (19, Figure 6-24) has failed.	Change referenced paragraph to "6-7.1.1.4". ay (19, Figure 6-24) IAW Paragraph 5-4.3.2.3.1. If found defective replace IAW Paragraph 6-7.1.1.
	NOTE Wear a static-free wristban Prior to handling ESDS items.	Change referenced paragraph to "6-7.1.2.1".
	7. PLC power supply 24VDC input module (10, Figure 6-25) has failed.	1. Test PLC power supply 24VDC input module (10, Figure 6-25) IAW Paragraph 5-4.3.2.2. If found defective, replace IAW Paragraph 6-7.1.2.

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	
1. PLC does not light up, touchscreen display (19, Figure 6-24) blank. (Continued)	8. Battle override switch (17, Figure 6-26) has failed.	1. Test battle override switch (17, Figure 6-26) IAW Paragraph 5-4.3.1.3. If found defective, replace IAW Paragraph 6-7.2.1.5.
	9. Power conditioner transformer (1, Figure 6-26) has failed.	1. Test power conditioner transformer (1, Figure 6-26) IAW Paragraph 5-4.3.1.1. If found defective, replace IAW Paragraph 6-7.2.1.1.
	10. Power supply transformer (6, Figure 6-25) has failed.	1. Test power supply transformer (6, Figure 6-25) IAW Paragraph 5-4.3.2.2. If found defective, replace IAW 6-7.1.3.
2. LPAC stops suddenly without going through unloaded operation or drain cycle.	1. PLC senses and displays a fatal fault.	1. Isolate problem further using fatal fault symptoms referenced in this Table. In addition, refer to Section 5-5 "WARNING AND FATAL FAULTS."
		WARNING Voltages dangerous to life exist when equipment is open and energized. Do not work alone.
	2. Overload relay (15, Figure 6-26) tripped.	1. Test overload relay (15, Figure 6-26) IAW Paragraph 5-4.4.5.2. If found defective, replace IAW 6-7.2.1.5.

Change referenced paragraph to "6-7.2.1.6".

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
3. **FATAL STATUS MAIN CONTACTOR** is shown on touchscreen display (19, Figure 6-24)	1. Overload relay (15, Figure 6-26) tripped.	***WARNING*** Voltages dangerous to life exist when equipment is open and energized. Do not work alone. 1. Test overload relay (15, Figure 6-26) IAW Paragraph 5-4.4.5.2. 2. Press STOP/RESET pushbutton switch (12, Figure 6-24). If drive motor tries to start but STOP/RESET pushbutton switch trips, replace drive motor IAW Paragraph 6-6.6. If drive motor does not attempt to start replace STOP/RESET pushbutton switch IAW Paragraph 6-7.1.1.2.
	2. Motor contactor (16, Figure 6-26) has failed. **NOTE** Wear a static-free wristband Prior to handling ESDS items.	1. Test motor contactor (16, Figure 6-26) IAW 5-4.4.5.3. If defective, replace IAW Paragraph 6-7.2.1.3.
	3. S5 relay contact motor/lights output module (6, Figure 7-2) has failed.	1. Test S5 relay contact motor/lights output module (6, Figure 7-2) IAW Paragraph 5-4.4.5.4. If defective, replace IAW 6-7 Change referenced paragraph to "6-7.1.1.2".
4. **FATAL AUTO/MANUAL SWITCH INPUT** is shown on touchscreen display (19, Figure 6-24).	1. PLC MAN/AUTO selector switch (10, Figure 6-24) has failed.	1. Replace MAN/AUTO selector switch (10, Figure 6-24) IAW Paragraph 6-7.1.1.

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
NOTE Battle Override Mode will subject the LPAC to risk of catastrophic damage should an undetected problem exist. Battle Override Mode should be reserved for battle conditions only.		
5. **BATTLE OVERRIDE ACTIVE** is shown on touchscreen display (19, Figure 6-24)	1. Battle override switch (17, Figure 6-26) on high voltage enclosure (HVE) has been positioned to ON. The CMS reverts to a monitor only maintenance mode. No action is taken by the CMS to any detected faults.	1. Fault clears when the battle override switch (17, Figure 6-26) is set to the OFF position. ***WARNING*** Voltages dangerous to life exist when equipment is open and energized. Do not work alone.
6. **FATAL SHUTDOWN HI TANK LIMIT** is shown on touchscreen display (19, Figure 6-24)	1. Separator tank water level at high limit switch setting.	1. Check water level through separator sight glass: a) If at high limit level (above sight) check tank drain solenoid IAW Paragraph 5-4.4.4.1. If defective, replace IAW 6-6.15.1. b) If within normal range (3/8 to 7/8 full in sight glass) replace water level switch IAW 6-6.16.2.

Insert "not".

Insert "(9, Figure 6-20)".

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
7. **FATAL SHUTDOWN LO TANK LIMIT** is shown on touchscreen display (19 Figure 6-24)	1. Separator water level at low limit switch setting.	1. Check water level through separator sight glass. a) If no water visible check fresh water supply to LPAC. b) If at low limit level (1/4 full in sight Insert "not". tank make-up solenoid valve IAW 5-4.4.4.1. If defective, replace IAW 6-6.15.1. c) If within normal range (3/8 to 7/8 full in sight glass) replace water level switch IAW 6-6.16.2.
	2. Foaming	2. Add antifoam agent IAW NOTE in Table 2-1. Insert "(9, Figure 6-20)".
8. **FATAL STATUS HIGH LIMIT SENSOR** is shown on touchscreen display (19, Figure 6-24)	1. Defective water level switch. Both high limit switches either open or closed at same time. In normal operation, one is closed when other is open.	1. Replace water level switch IAW 6-6.16.2.
	2. Foaming	1. Add antifoam agent IAW NOTE in Table 2-1.
9. **FATAL STATUS LO LIMIT SENSOR** is shown on touchscreen display (19, Figure 6-24)	1. Defective water level switch. Low limit switch is open. In normal operation switch closes on rise.	1. Replace water level switch IAW 6-6.16.2.
	2. Foaming	1. Add antifoam agent IAW NOTE in Table 2-1.

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
10. **FATAL LO INJ FRESHWATER PRESS** is shown on touchscreen display (19, Figure 6-24)	1. Injection water pressure below PLC default setting.	1. Check for a clogged water filter and replace IAW Paragraph 6-6.14. 2. Check for a restriction in injection water loop and repair IAW Paragraph 6-6.9 or 6-6.10. 3. Test injection water pressure transducer IAW Paragraph 5-4.4.1.2. If defective, replace IAW 6-6.17.
11. **FATAL HI INJ FRESHWATER PRESS** is shown on touchscreen display (19, Figure 6-24)	1. Injection water pressure above PLC default setting.	1. Check separator water level through sight glass. a) If above normal high level, test tank make-up solenoid valve IAW 5-4.4.4.1. If defective, replace IAW 6-6.15.1. b) If make-up solenoid valve is not defective, test injection water pressure transducer IAW Paragraph 5-4.4.1.2. If defective, replace IAW 6-6.17.

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
12. **FATAL HI DISCHARGE AIR PRESS** is shown on touchscreen display (19, Figure 6-24)	1. Discharge air pressure is above PLC default setting.	1. Check for blockage in air discharge piping and repair IAW Paragraph 6-5.8. 2. Have ship check system back-check valve and repair IAW 6-6.3.2. 3. Test pressure transducer IAW Paragraph 5-4.4.1.2. If defective, replace IAW 6-6.17.
13. **FATAL HI AIR DISCHARGE TEMP** is shown on touchscreen display (19, Figure 6-24)	1. Discharge air temperature is above PLC default setting.	1. Repair heat exchanger IAW Paragraph 6-6.18. 2. Check that seawater temperature and flow rate being supplied to the LPAC is within limits specified in Table 1-1. If not, problem is with ship's seawater system. 3. Check that temperature of fresh water being supplied to the LPAC is within limits specified in Table 1-1. If not, problems is with ship's potable (fresh) water system. 4. Check that inlet air temperature is within limits specified in Table 1-1. If not, problem is with LPAC compartment temperature.

Revise to read "Check the air end check valve (1, □ Figure 6-6). Repair or replace IAW Paragraph 6-6.3.2".

Table 5-1. CMS and Electrical Components Trou

Per Discussion with Bill Nelson (per phone con 2-6-03), add item number assigned to Figure 7-10 to identify the switch. I.e.: (X, Figure 7-10). Also need a new Chapter 6 paragraph text instructions for removal and replacement of same

SYMPTOM	PROBABLE CAUSE	
14. **FATAL ACTIVE DISCH TEMP SWITCH** is shown on touchscreen display (19, Figure 6-24)	1. Backup discharge air temperature switch has activated.	1. Check to see if PLC touchscreen display (19, Figure 6-24) is also displaying **FATAL HI DISCHARGE TEMP** a) If so, isolate IAW fault message 13. b) If not, replace discharge air high Temperature back-up switch.
15. **STATUS ERROR HI LEVEL SENSOR** is shown on touchscreen display (19, Figure 6-24)	1. High-level water level switch has failed to operate IAW expected logic pattern. 2. Foaming	1. Replace water level switch IAW 6-6.16.2. 2. Add antifoam agent IAW NOTE in Table 2-1.
16. **STATUS ERROR NORM LEVEL SENSOR** is shown on touchscreen display (19, Figure 6-24)	1. Normal level water leve switch has failed to ope IAW expected logic pattern. 2. Foaming	Insert "(9, Figure 6-20)". ~~r level switch~~ IAW 6-6.16.2 2. Add antifoam agent IAW NOTE in Table 2-1.
17. **STATUS ERROR LOW LEVEL SENSOR** is shown on touchscreen display (19, Figure 6-24)	1. Low level water level switch has failed to operate IAW expected logic pattern. 2. Foaming	1. Replace water level switch IAW 6-6.16.2 2. Add antifoam agent IAW NOTE in Table 2-1.

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
NOTE This message will only appear when LPAC is running.		***WARNING*** Voltages dangerous to life exist when equipment is open and energized. Do not work alone.
18. **TANK DRAIN TIME LIMIT EXCEEDED** is shown on touchscreen display (19, Figure 6-24)	1. Extended drain action may be due to a tank drain solenoid valve failure.	1. Test tank drain solenoid valve IAW Paragraph 5-4.4.4.2. If found defective, replace IAW 6-6.15.1. **NOTE** Wear a static free wristband prior to handling ESDS items.
	2. Extended drain action may be due to S4 relay contact valves output module (6, Figure 7-2) failure.	1. Test S4 relay contact valves output module (6, Figure 7-2) IAW Paragraph 5-4.4.4.3. If found defective, replace IAW Paragraph 6-7.1.2.1.
	3. Foaming.	1. Add antifoam agent IAW NOTE in Table 2-1.
19. **POSSIBLE MAKE-UP VALVE FAILURE** is shown on touchscreen display (19, Figure 6-24)	1. Extended fill time may be due to a make-up solenoid valve failure.	1. Test make-up solenoid valve IAW Paragraph 5-4.4.4.2. If found defective, replace IAW 6-6.15.1.
	2. Extended fill time may be due to S4 relay contact valves output module (6, Figure 7-2) failure.	1. Test S4 relay contact valves output module (6, Figure 7-2) IAW Paragraph 5-4.4.4.3. If found defective, replace IAW Paragraph 6-7.1.2.1.
	3. Foaming.	1. Add antifoam agent IAW NOTE in Table 2-1.

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
CAUTION Operating LPAC with low injection water pressure can cause damage to internal air-end components.		
20. **INJECTION WATER PRESSURE LOW** is shown on touchscreen display (19, Figure 6-24). **NOTE** If the CMS detects this condition while the LPAC is running it will initiate an automatic shut-down and display the fatal fault message **FATAL LO INJ FRESHWATER PRESS**	1. Possible injection water pressure transducer failure.	1. Test pressure transducer IAW Paragraph 5-4.4.1.2. If defective, replace IAW Paragraph 6-6.17.
21. **AIR DISCHARGE PRESSURE LOW** is shown on touchscreen display (19, Figure 6-24).	1. Discharge air pressure is below the CMS default setting due possibly to air leaks.	1. Using a soapy solution check air piping, fittings and connections for air leaks. Tighten any loose connections that are found. If piping connections require new gaskets, have qualified personnel replace gasket.

Include probable cause of "clogged/dirty closed loop water filter" with appropriate remedy.

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
22. **SHIPBOARD AIR PRESSURE LOW** is shown on touchscreen display (19, Figure 6-24).	1. Shipboard air pressure is below CMS default setting due possibly to air leaks.	1. Using a soapy solution check air piping, fittings and connections for air leaks. Tighten any loose connections that are found. If piping connections require new gaskets, have qualified personnel replace gasket.
23. **HI SEAWATER DISCHARGE TEMP** is shown on touchscreen display (19, Figure 6-24).	1. Seawater discharge temperature is above CMS default setting due to high seawater temperature, clogged heat exchanger or high temperature surrounding the LPAC.	1. Ensure temperature and seawater flow rate being supplied to the LPAC is within Table 1-1 limits. 2. Ensure ambient inlet temperature is within Table 1-1 limits. 3. Repair heat exchanger IAW Paragraph 6-6.18. 4. Test discharge temperature transducer IAW Paragraph 5-4.4.2.2. If defective, replace IAW Paragraph 6-6.21.
24. **HI SEAWATER INLET TEMP** is shown on touchscreen display (19, Figure 6-24).	1. Seawater inlet temperature is above CMS default setting due to high seawater temperature, clogged heat exchanger or high temperature surrounding the LPAC.	1. Ensure temperature and seawater flow rate being supplied to the LPAC is within Table 1-1 limits. 2. Test cooling water inlet temperature transducer IAW Paragraph 5-4.4.2.2. If defective, replace IAW Paragraph 6-6.21.

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
25. **LO AIR DISCHARGE TEMP** is shown on touchscreen display (19, Figure 6-24).	1. Temperature of discharge air is below CMS default setting due to low seawater, injection water or inlet air temperature.	1. Ensure temperature and seawater flow rate being supplied to the LPAC is within Table 1-1 limits. 2. Ensure inlet air temperature is within Table 1-1 limits. 3. Ensure temperature of injection water is within Table 1-1 limits. 4. Test discharge temperature transducer IAW Paragraph 5-4.4.2.2. If defective, replace IAW Paragraph 6-6.21.
26. **HIGH AIR DISCHARGE TEMP** is shown on touchscreen display (19, Figure 6-24).	1. Temperature of discharge air is above CMS setting due to high seawater temperature, inlet air temperature or defective heat exchar	1. Ensure temperature and seawater flow rate being supplied to the LPAC is within Table 1-1 limits. 4. Test discharge temperature transducer IAW Paragraph 5-4.4.2.2. If defective, replace IAW Paragraph 6-6.21.

Chapter 7 (1, Figure 7-10) lists the transducer as a "Detector". Make the necessary change(s) to be consistent between Table 5-1 and Table 5-3. Also change the Table of Contents to suit paragraph 6-6.21.

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
27. **LO INJECTION FRESHWATER TEMP** is shown on touchscreen display (19, Figure 6-24).	1. Temperature of injection water is below CMS default setting due to low seawater, injection water or inlet air temperature.	1. Ensure temperature and seawater flow rate being supplied to the LPAC is within Table 1-1 limits. 2. Ensure inlet air temperature is within Table 1-1 limits. 3. Ensure temperature of injection water is within Table 1-1 limits. 4. Test discharge temperature transducer IAW Paragraph 5-4.4.2.2. If defective, replace IAW Paragraph 6-6.21.
28. **HI INJECTION FRESHWATER TEMP** is shown on touchscreen display (19, Figure 6-24).	1. Temperature of inj[illegible] is above CMS setti[illegible] high seawater temp[illegible] or defective heat e[illegible]	1. [illegible] 6-6.18. 3. Test injection water temperature transducer IAW Paragraph 5-4.4.2.2. If defective, replace IAW Paragraph 6-6.21.

Chapter 7 (1, Figure 7-10) lists the transducer as a "Detector". Make the necessary change(s) to be consistent between Table 5-1 and Table 5-3. Also change the Table of Contents to suit paragraph 6-6.21.

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
		WARNING Voltages dangerous to life exist when equipment is open and energized. Do not work alone.
29. Inadequate or no power being supplied to ON/OFF selector switch (9, Figure 6-24), motor contactor (16, Figure 6-26) coil, battle override switch (17, Figure 6-26), blowdown and shut off solenoid valves.	1. Power conditioner transformer (1, Figure 6-26) has failed or is providing inadequate output voltage.	1. Ensure shipboard 440VAC 3-phase electrical supply is being supplied to primary coil of power conditioner transformer (1, Figure 6-26). 2. Replace power conditioner transformer (1, Figure 6-26) IAW Paragraph 6-7.2.1.1.
30. Motor contactor (16, Figure 6-26) doesn't close.	1. Overload relay (15, Figure 6-26) has tripped.	1. Reset overload relay (15, Figure 6-26) by pressing STOP/RESET pushbutton switch (12, Figure 6-24). 2. If overload relay (15, Figure 6-26) does not reset after pressing STOP/RESET pushbutton switch (12, Figure 6-24), test overload relay (15, Figure 6-26) IAW Paragraph 5-4.4.5.2. If found defective, replace overload relay (15, Figure 6-26) IAW Paragraph 6-7.2.1..5.
	2. Motor contactor (16, Figure 6-26) coil has not "pulled in".	1. Test motor contactor (16, Figure 6-26) coil IAW Paragraph 5-4.4.5.3. If found defective, replace motor contactor IAW Paragraph 6-7.2.1.3.
	3. Motor contactor (16, Figure 6-26) has failed.	1. Test motor contactor (16, Figure 6-26) IAW Paragraph 5-4.4.5.3. If found defective, replace motor contactor IAW Paragraph 6-7.2.1.3.

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
		WARNING Voltages dangerous to life exist when equipment is open and energized. Do not work alone.
31. Overload relay (15, Figure 6-26) tripped, shutting down LPAC. ***CAUTION*** No safeties are active during Battle Override Operation. It does not monitor or shutdown for any compressor failure. The water level must be manually controlled by an operator.	1. Drive motor overheating due to motor windings overheating, defective drive motor bearings, dirty drive motor air screens or windings. Possibly caused by excessive amperage draw at drive motor due to locked rotor.	1. Reset overload relay (15, Figure 6-26) by pressing STOP/RESET pushbutton switch (12, Figure 6-24). 2. Inspect for signs of burnt, open, incorrectly connected or shorted wiring IAW Paragraph 5-3.2 step o. 3. Test overload relay (15, Figure 6-26) IAW Paragraph 5-4.4.5.2. If defective, replace IAW Paragraph 6-7.2.1.5. 4. Clean air screens and windings IAW Paragraph 6-6.6. 5. Replace drive motor IAW Paragraph 6-6.6.

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
NOTE Battle Override Mode will subject the LPAC to substantial risk of catastrophic damage should an undetected problem exist. Battle Override Mode should be reserved for battle conditions only.		***WARNING*** Voltages dangerous to life exist when equipment is open and energized. Do not work alone.
32. When battle override switch (17, Figure 6-26) is positioned to ON motor contactor (16, Figure 6-26) doesn't close, LPAC doesn't start, and/or blowdown and injection water solenoid valves don't activate.	1. Battle override switch (17, Figure 6-26) or one of its contact blocks has failed. 2. Power conditioner transformer (1, Figure 6-26) has failed.	Change to "6-7.2.1.6". 1. Test battle override switch (17, Figure 6-26) IAW 5-4.3.1.3. If found defective, replace battle override switch (17, Figure 6-26) IAW Paragraph 6-7.2.1. 1. Replace power conditioner transformer IAW Paragraph 6-7.2.1.1.
33. Single solenoid valve won't activate-all other solenoid valves functional.	1. Fuse providing protection for solenoid valve circuit has opened.	1. Refer to Paragraph 5-4.4.4.2 step e for solenoid valve circuit and fuse information. Replace with known good fuse of same rating.

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
		WARNING Voltages dangerous to life exist when equipment is open and energized. Do not work alone.
34. When the ON/OFF selector switch (9, Figure 6-24) is positioned to ON the PLC doesn't light up and the LPAC doesn't start.	1. No power to LPAC.	1. Turn-on main power supply to LPAC.
	2. Power conditioner transformer (1, Figure 6-26) has failed.	1. Replace power conditioner transformer IAW Paragraph 6-7.2.1.1.
	3. ON/OFF selector switch (9, Figure 6-24) has failed.	1. Test ON/OFF selector switch (9, Figure 6-24) IAW Paragraph 5-4.3.2.1. If defective, replace IAW Paragraph 6-7.1.1.
	4. Power supply transformer fuse F1 (refer to wiring schematic) has opened.	1. Replace with known good fuse of equal rating. If replacement fuse opens as soon as power is applied replace power supply transformer (6, Figure 6-25) IAW Paragraph 6-7.1.3.
35. The MOTOR RUNNING indicator lamp (13, Figure 6-24) does not glow green when the LPAC drive motor is running.	1. MOTOR RUNNING indicator bulb (41, Figure 6-24) has failed.	1. Replace MOTOR RUNNING indicator bulb (41, Figure 6-24) IAW Paragraph 6-7.1.1.2.
36. The WARN/FAIL indicator lamp (14, Figure 6-24) does not glow red when the PLC detects and displays a WARNING or FATAL fault.	1. The WARN/FAIL indicator bulb (41, Figure 6-24) has failed.	1. Replace WARN/FAIL indicator bulb (41, Figure 6-24) IAW Paragraph 6-7.1.1.2.

Change to "6-7.1.1.2".

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
37. Hours meter (15, Figure 6-24) does not advance with the LPAC drive motor energized.	1. Hours meter (15, Figure 6-24) has failed.	1. Test hours meter (15, Figure 6-24) IAW Paragraph 5-4.3.2.3.4. If defective, Replace IAW 6-7.1.1.3. 2. Wire loose on S5 Relay Contact/Lights Output Module (6, Figure 7-2). With power disconnected to LPAC, open module door and check all wires for tightness and any obvious signs of discoloration or burning. **NOTE** Wear a static free wristband prior to handling ESDS items.
38. PLC touchscreen display (19, Figure 6-24) showing multiple failures including separator tank water level sensors, MAN/AUTO switch failure, battle override switch failure and back up air temp switch failure.	1. S1 DC Sink Input Module (3, Figure 7-2) has failed.	1. Test S1 DC Sink Input Module IAW Paragraph 5-4.4.3.2. Replace IAW Paragraph 6-7.1.2.1.
39. PLC touchscreen display (19, Figure 6-24) shows that all pressure sensors have failed.	1. S2 8-Channel Analog Input Module (4, Figure 7-2) has failed.	1. Test S2 Analog Input Module IAW Paragraph 5-4.4.1.3. Replace IAW Paragraph 6-7.1.2.1.

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
		NOTE Wear a static free wristband prior to handling ESDS items.
40. PLC touchscreen display (19, Figure 6-24) shows multiple temperature transducer failures.	1. S3 Temperature RTD Input Module (5, Figure 7-2) has Failed.	1. Test S3 Temperature RTD Input Module IAW Paragraph 5-4.4.2.3. Replace IAW Paragraph 6-7.1.2.1.
41. PLC touchscreen display (19, Figure 6-24) shows multiple water level switch failures.	1. S1 DC Sink Input Module (3, Figure 7-2) has failed.	1. Test S1 DC Sink Input Module IAW Paragraph 5-4.4.3.2. Replace IAW Paragraph 6-7.1.2.1.
42. PLC touchscreen display (19, Figure 6-24) shows multiple or total solenoid valve failures.	1. S4 Relay Contact Valves Output Module (6, Figure 7-2) has failed.	1. Test S4 Relay Contact Valves Module IAW Paragraph 5-4.4.4.3. Replace IAW Paragraph 6-7.1.2.1.
43. PLC touchscreen display (19, Figure 6-24) shows **FATAL STATUS MAIN CONTACTOR** along with failure of the MOTOR RUNNING indicator lamp 13, Figure 6-24) to glow and/or failure of the WARN/ FAIL indicator lamp (14, Figure 6-24) to glow and/or failure of the hours meter (15, Figure 6-24).	1. S5 Relay Contact Motor/Lights Output Module (6, Figure 7-2) Has failed.	1. Test S5 Relay Contact Motor/Lights Output Module IAW Paragraph 5-4.4.5.4. Replace IAW Paragraph 6-7.1.2.1.

Table 5-1. CMS and Electrical Components Troubleshooting Chart (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
44. The PLC touchscreen display (19, Figure 6-24) shows a message indicating a single pressure transducer failure.	1. Pressure transducer failure.	1.
45. The PLC touchscreen display (19, Figure 6-24) shows a message indicating a single temperature transducer failure.	1. Temperature transducer failure.	1. Test temperature transducer IAW Paragraph 5-4.4.2.2. If found defective, replace IAW Paragraph 6-6.21.

Chapter 7 (1, Figure 7-10) lists the transducer as a "Detector". Make the necessary change(s) to be consistent between Table 5-1 and Table 5-3. Also change the Table of Contents to suit paragraph 6-6.21.

CHAPTER 6
CORRECTIVE MAINTENANCE

6-1. INTRODUCTION.

6-1.1 Purpose. Chapter 6 provides corrective maintenance procedures for the model STAR 200 low-pressure air compressor (LPAC). It provides maintenance personnel with the procedures necessary to return the LPAC to a normal operating condition once the cause of an equipment malfunction has been identified.

6-1.2 Scope. Chapter 6 provides procedures to calibrate, adjust, and align the LPAC. Procedures to disassemble, repair, and reassemble all repairable parts, modules, assemblies, and subassemblies of the LPAC are also included. These procedures identify the actions to be accomplished along with safety precautions to be observed; list of tools, parts, materials, and test equipment required; provides preliminary control settings; describes test equipment set-up procedures; and provides step-by-step procedures to accomplish the maintenance task.

6-1.3 Arrangement. Section I provides calibration, adjustment, and alignment procedures for the LPAC. Section II provides repair and replacement procedures (including detailed illustrated disassembly, repair/replacemen

6-1.4 Tools, Equ tools and equipment are recommended for use in the performance of maintenance tasks described in this chapter:

1) Socket wrench set: 7/16" through 1-5/16" sockets with 1/2" drive.
2) Socket wrench 1-7/16" with 3/4" drive.
3) 6" slip joint pliers.
4) Box/open end wrench set: 7/16" through 1-5/16".
5) Set of adjustable wrenches (up to 2-5/8").
6) Hex key (Allen wrench) set.
7) Industrial face shield and goggles.
8) Rubber gloves.
9) Insulated gloves.
10) Prick punch.
11) Machinist hammer.
12) Soft metal hammer.
13) 8" inside micrometer caliper.
14) 8" outside micrometer caliper.
15) 12" inside/outside vernier caliper.
16) Torque wrench (0 to 400 foot pounds (ft. lbs.) with 3/4" drive plus adapter to 1/2" drive.
17) Magnifying glass.
18) Inside snap-ring pliers.
19) Marker pens.
20) Machinist scribe.
21) Dial indicator (.001" graduations) with magnetic base.
22) Feeler gauges (.001", .0015", .002", up to .025").
23) Shim stock (1/16, 1/8, 3/16, & 1/4).
24) 6" machinist scale.
25) Bearing puller for 2.36" inside diameter (I.D.) bearing.
26) Flashlight.
27) Screwdrivers (various sizes).
28) Lapping plate.
29) Electrical tape.
30) Chain hoist (1-1/2 ton capacity) with slings, hooks, webbing, etc.
31) Independently measured air pressure source.
32) Hex nut, 7/8"-9UNC, steel plated (2 required).
33) 1-1/4" angle-headed, open-end wrench.
34) Short 1/2" open-end wrench.
35) Soft-jawed pliers.
36) Thin (3/8" thick head maximum) 2-1/8" wrench.
37) Metal eye-bolt with 1/2"-13UNC threads.
38) Digital voltmeter/continuity tester - Dynascan Corporation BK Precision (FSCM 18110) model 2800 or equivalent.
39) Clamp-on ammeter - Amprobe (FSCM 15566) model ACDC 1000 or equivalent.
40) Compressor (air-end) support fixture - RIX Industries (FSCM 28953) part number 33-AFIX100 or equivalent.
41) Housing indicator fixture - RIX Industries (FSCM 28953) part number 33-AIND1003 or equivalent.
42) Main rotor locating tool - RIX Industries (FSCM 28953) part number 88-B5658 or equivalent.
43) Seal/Bearing assembly tool - RIX Industries (FSCM 28953) part number 33-TOOL4.

Global comment: Change all reverse quote marks to ″ the inch symbols when found as dimensional references.

44) Rotor spacer ring - RIX Industries (FSCM 28953) part number 33 - TOOL1 or equivalent.

45) Bearing ring - RIX Industries (SCM 28953) part number 33-TOOL2 or equivalent.

46) Bearing lock nut tool - RIX Industries (FSCM 28953) part number 33-B5844 or equivalent.

47) Shaft tool - RIX Industries (FSCM 28953) part number 88-B5659 or equivalent.

48) Dial indicator mounting plate - RIX Industries (FSCM 28953) part number 33-A7630 or equivalent.

49) Bearing lock nut torque tool - RIX Industries (FSCM 28953) part number A33-B5743 or

Add "52) V-ring installation tool, RIX Industries, FSCM 28593, P/N B6294.".

51) PLIOBOND 30 adhesive - W.J. Roscoe Co., Akron, Ohio 44301 or equivalent.

SECTION I

Add "53) Puller, gauge needle.

CALIBRATION, ADJUSTMENT, AND ALIGNMENT

6-2. CALIBRATION PROCEDURES.

6-2.1 Programming. This section describes the programming methods for the programmable logic controller (PLC). A complete listing is provided to cover changing the parameters of PLC operation. The PLC has default values set into the software program. For any default value that is sufficient for LPAC operation the corresponding programming step may be omitted.

6-2.2 PLC Calibration. (Refer to Figure 2-4.15) The LPAC contains four temperature sensors and three pressure transducers. PLC pressure transducer calibration is not available or necessary. The temperature sensors however, can be calibrated using either the FACTORY CALIB LOW button or the AUTO CALIB LOW button, providing the operator with factory default settings or automatic sensor calibration. The PLC will not calibrate sensors that are under pressure. Calibration will only be accomplished if sensors are at 0 psi or low pressure. To calibrate temperature sensors using PLC touchscreen display (3, Figure 2-1) proceed as follows:

a) Ensure the LPAC is in the manual mode by setting the PLC MAN/AUTO selector switch (4, Figure 2-1) to MAN and pressing the START pushbutton switch (6, Figure 2-1), displaying the PLC Main Screen (refer to Figure 2-4.1).

b) Unscrew knurled knob on touchscreen display (3, Figure 2-1) cover and lift to expose touchscreen for PLC data entry.

c) Press the ENTER MAINTENANCE MODE button on the Main Screen (refer to Figure 2-4.1), displaying MAINTENANCE SCREEN 1 (refer to Figure 2-4.8).

d) Press CALIBRATE PRESSURE TRANSDUCERS button displaying Maintenance Screen 8 (refer to Figure 2-4.15).

laintenance Screen 8 (refer to Figure 2-4.15) lows PLC calibration of the injection air, discharge air and shipboard air sensors.

f) Select sensor to calibrate and press FACTORY CALIB LOW button once to calibrate sensors to factory defaults. Pressing FACTORY CALIB LOW button twice brings up AUTO CALIB LOW button (refer to Figure 2-4.15). Pressing AUTO CALIB LOW button automatically calibrates sensors.

g) Pressing the PRESS TO CALIB button (refer to Figure 2-4.15) on the right-hand side of screen will calibrate appropriate sensor to either the factory default settings or to automatic calibration settings.

h) If PLC screen displays CALIBRATION FAILURE (refer to Figure 2-4.15) when PRESS TO CALIB button is pressed, there is either pressure being applied to sensor or LPAC has a failed transducer.

i) Replace failed transducer (IAW paragraph 6-3.3) or recalibrate sensor by repeating steps above until pressure is removed from sensor, allowing it to be calibrated to either factory default settings or automatic calibration.

j) Upon successful sensor calibration, press MAINT SCREEN 1 button (refer to Figure 2-4.15). PLC displays Maintenance Screen 1 Operating Data and Service (refer to Figure 2-4.8)

k) Press MAIN MENU button (refer to Figure 2-4.15). PLC displays Main Screen (refer to Figure 2-4.1).

l) Close and secure PLC touchscreen display (3, Figure 2-1) cover.

m) Restore LPAC to normal working mode.

6-2.3 Pressure Gauge Calibration. (Index numbers below refer to Figure 6-2 unless otherwise indicated.) This procedure tests pressure gauges on gauge panel (4, Figure 2-2). Use a portable gauge tester and an oil-free air supply to test gauges. If necessary, calibrate gauges as follows:

a) Close gauge valves (5, 7, and 9, Figure 2-2) isolating three pressure gauges on gauge panel.

b) Disconnect tubing at gauge stem connector (1, Figure 6-1) and attach portable gauge tester to gauge being tested.

c) Test gauge at 0%, 25%, 50%, 75% and 100% of its scale range. If resultant error is within 1% of range (i.e.: 2 pounds on a 200 pound gauge), the gauge is operating satisfactorily.

d) Test for "zero adjustment". If error observed is above 1% but is constant (such as 6 psi high or low over the entire range), it can be readily calibrated as follows:

1) Using a small screwdriver, remove crystal retaining ring (1). Remove crystal (2) from case (3) of gauge being adjusted.
2) Loosen three dial mounting screws (4), rotate dial (5) to correct error and tighten dial mounting screws (4).
3) If dial mounting screw slots are not large enough to allow enough adjustment, pointer (6) must be removed and repositioned.

CAUTION

Pointer assembled to shaft using Loctite. Prying-off will damage gauge.

4) Using hot soldering iron tip, loosen Loctite on end of dial shaft. Carefully remove pointer using a pointer jack. Do not allow Loctite to run down pointer shaft into eyelet (7).
5) Set dial (5) with dial mounting screws (4) in center of screw slots.
6) Place 1/2 drop of Loctite (Grade A) in hole at pointer hub. Wipe off any excess Loctite and install pointer (6) onto shaft with pointer aligned to zero.
7) Correct any slight error by repeating step (2) above.
8) Recheck calibration at various points of scale. If satisfactory, install crystal (2) and crystal retaining ring (1) into case (3).

e) If pointer moves more, or less, than required for pressure change applied, gauge span can be calibrated as follows:

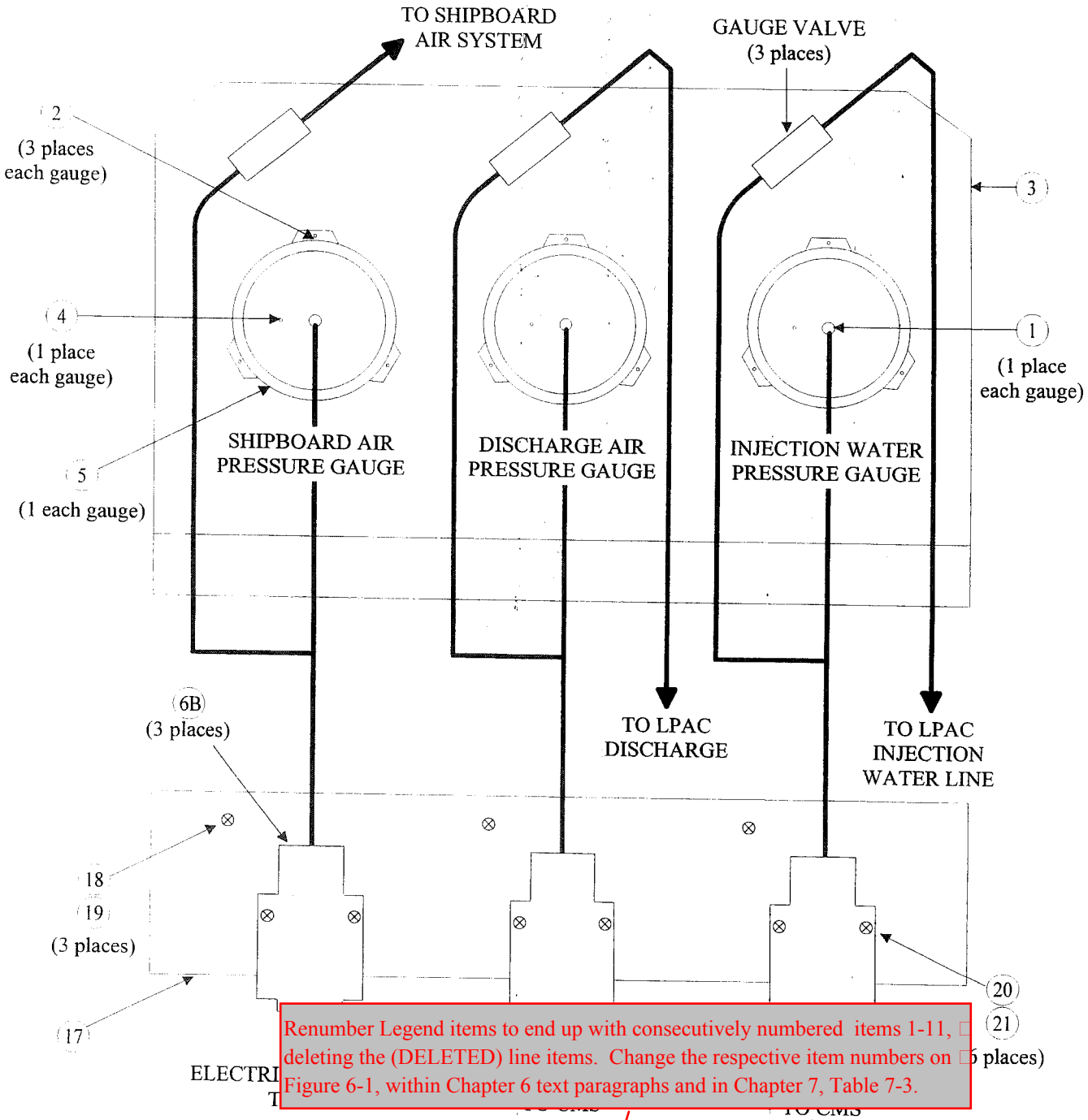
Disconnect gauge stem connector (1, Figure 6-1) of gauge requiring adjustment.

1) Remove three gauge mounting screws (2, Figure 6-1) and leaving crystal (2) and crystal retaining ring (1) attached to gauge panel (4, Figure 2-2), remove gauge requiring adjustment out back of gauge panel (4, Figure 2-2). Place gauge on suitable work surface.

Remove gauge cover screw (4, Figure 6-1), gauge cover (5, Figure 6-1), and gasket (12) from case (3).

2) Loosen slide screw (13) and adjust slide link (14) to either increase or decrease distance between bourdon tube (15) and movement (17) by approximately .005". Increase length to shorten pointer movement or decrease to lengthen it.
3) When properly set, tighten slide screw (13).
4) If required, repeat steps d. (2) through d. (6) above to align pointer.
5) Attach portable gauge tester and recheck accuracy.
6) Repeat steps (2) through (4) above until gauge accuracy is within 1% over the entire range.
7) Replace gasket (12) and install gauge cover (11) on case (3) using gauge cover screw (4, Figure 6-1).
8) Replace gauge in gauge panel (4, Figure 2-2) and install three gauge mounting screws (2, Figure 6-1).
9) Connect gauge stem connector (1, Figure 6-1).

f) If pointer moves an increasing (or decreasing) distance when equal increments of pressure are applied (ex. 2% high at 25% range, 4% high at 50% range and 8% high at 100% range), gauges linear movement can be calibrated as follows:

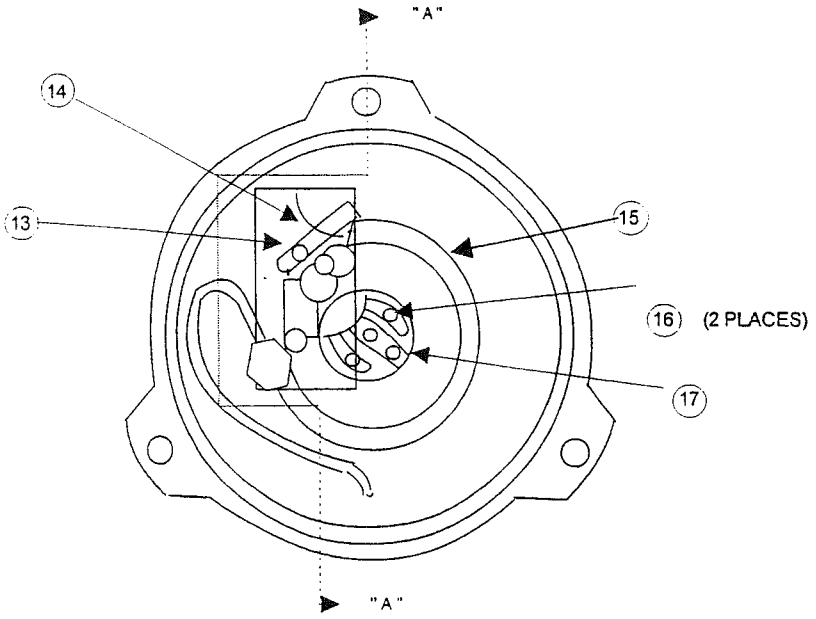


Renumber Legend items to end up with consecutively numbered items 1-11, deleting the (DELETED) line items. Change the respective item numbers on Figure 6-1, within Chapter 6 text paragraphs and in Chapter 7, Table 7-3.

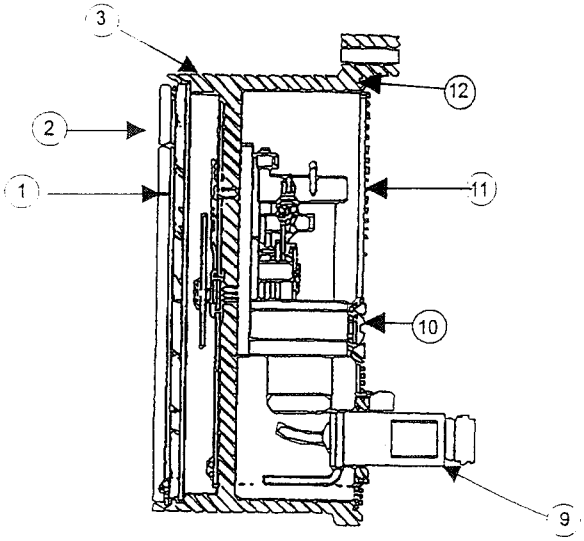
LEGEND

1. GAUGE STEM CONNECTOR
2. GAUGE MOUNTING SCREW
3. GAUGE PANEL
4. GAUGE COVER SCREW
5. GAUGE COVER
6B. PRESSURE TRANSDUCER
7. (DELETED)
8. (DELETED)
9. (DELETED)
10. (DELETED)
11. (DELETED)
12. (DELETED)
13. (DELETED)
14. (DELETED)
15. (DELETED)
16. (DELETED)
17. ADAPTER PLATE
18. CAPSCREW
19. LOCKWASHER
20. CAPSCREW
21. WASHER

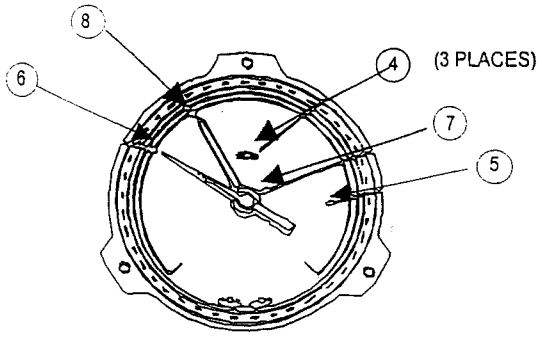
Figure 6-1. Pressure Gauge Panel/Pressure Transducer



REAR VIEW (BACK COVER REMOVED)



SECTIONAL VIEW "A" - "A"



FRONT VIEW

LEGEND

1. CRYSTAL RETAINING RING
2. CRYSTAL
3. CASE
4. DIAL MOUNTING SCREWS
5. DIAL
6. POINTER
7. EYELET
8. RED POINTER
9. STEM CONNECTOR
10. GAUGE COVER SCREW
11. GAUGE COVER
12. GASKET
13. SLIDE SCREW
14. SLIDE LINK
15. BOURDON TUBE
16. MOVEMENT SCREW
17. MOVEMENT

Figure 6-2. Pressure Gauge

1) Perform steps e. (1) through e. (3) above.
2) Loosen movement screw (16) and rotate movement (17) toward tip of bourdon tube (15) to correct for increasing movement and away from the tip for a decreasing movement.

NOTE

Rotating the movement too far in either direction will cause pointer movement to become restricted at one end of scale.

3) If non-linear characteristic of pointer movement cannot be eliminated within rotation limits of movement, bourdon is faulty. Replace gauge (IAW paragraph 6-6.12).
4) If pointer moves erratically when gauge is tested, movement may have become contaminated with dirt or oil, or may be excessively worn. Use a non-flammable solvent to clean all bearings, gearing, and linkage of dust, dirt, or grease.
5) If excessive wear in movement or linkage components, or if bourdon tube has been damaged (as evidenced by a bulge in oval section of tube), replace gauge (IAW paragraph 6-6.12).
6) When properly set, tighten move (16).
7) Attach portable tester and reche movement. Repeat steps (2) and necessary, to obtain linear move
8) Perform steps e. (7) through e. (9) above.

g) Open gauge valves (5, 7, and 9, Figure 2-2) and restore LPAC to normal operation.

6-3. ADJUSTMENTS.

6-3.1 High Pressure Relief Valve Adjustment. (Index numbers below refer to Figure 6-3 unless otherwise indicated.) High-pressure relief valve has been set by manufacturer to release at 150 to 175 psig. This procedure is used for both the separator relief valve and on the air-end. To adjust valve:

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.
b) If LPAC is running, press **STOP/RESET** push-button switch (7, Figure 2-1).
c) Turn OFF and lockout main power source for LPAC. Install OUT-OF-SERVICE tag.

WARNING

Compressed air is dangerous. Ensure relief valve air lines are drained to atmospheric pressure before disconnecting valve.

d) Ensure discharge air pressure gauge (8, Figure 2-2) reads "0".
e) Remove high-pressure relief valve (2, Figure 2-2) by Unscrewing tailpiece (16) from separator.

Revise text through-out paragraph 6-3 to reflect paragraph 6-3 of T/M 6220-EE-MMA-010 Change F, modified to represent the two stem guided HP relief valves (150 and 175 PSI). Refer to Figure 6-3.2. Utilize item numbers to match T/M 6220-EE-MMA-010, Change F Figure 6-3.2.

...rable air source

Pressure air is dangerous. Remain clear of relief valve discharge elbow (10).

h) Loosen locknut (3). Then apply 149 or 174 psig to valve.
i) If relief valve is releasing applied pressure, turn pressure screw (2) clockwise until release of air stops.
j) Gradually increase applied air pressure to 151 psig. If relief valve does not start releasing applied pressure at 150 or 175 psig, turn pressure screw (2) counter-clockwise until valve releases air.
k) Repeat steps g. through i. above until relief valve holds pressure to 150 or 175 psig and releases pressure above that point.

NOTE

Replace relief valve if it cannot be adjusted to proper release pressure.

l) Tighten locknut (3), making sure to hold pressure screw (2) position.

m) Install hood (1).

WARNING

Pressure air released by relief valve is dangerous. Ensure valve installed with discharge elbow (10) directed downward.

n) Reinstall high-pressure relief valve on separator assembly or air end using a new o-ring (17).

o) Restore LPAC to normal operation.

6-3.2 Air Filter Differential Pressure Indicator Adjustment If air filter pressure pop-up indicator (1, Figure 2-2) becomes visible it is time to replace air filter element. No adjustment is necessary other than to p down the red indicator, resetting the device.

Delete.

6-3.3 Pressure Transducer Adjustment. (Index numbers below refer to Figure 6-1 unless otherwise indicated.) There are no zero and span adjustments for the new style pressure transducers (6 B, Figure 6-1).

ID the new style transducer(s) by make and model.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

b) If LPAC is running, press **STOP/RESET** pushbutton switch (7, Figure 2-1).

WARNING

Compressed air is dangerous. Ensure that internal air pressure is at atmosphere pressure before proceeding.

c) Ensure discharge air pressure gauge (8, Figure 2-2) reads "0".

d) Remove two capscrews (20) and washers (21). Install replacement transducer (6B). Reinstall washers (21) and capscrews (20).

e) Recalibrate pressure transducer (6B) (IAW paragraph 6-2).

f) Restore LPAC to normal operation.

Delete. Re: The subparagraph 6-3.3 states that the transducers are non adjustable.

6-4. ALIGNMENTS

6-4.1 Motor Shaft Coupling Alignment. (Refer to Figure 6-4.) Coupling alignment is automatically ensured by the fit of the distance piece (16, Figure 6-4) to the motor (9, Figure 6-4) and the distance piece (16, Figure 6-4) to the compressor. Ensure that the coupling hub locknuts are torqued to 30 ft. lbs.

SECTION II
REPAIR AND REPLACEMENT

6-5. GENERAL

6-5.1 Preliminary. It may be necessary to refer to chapter 5 to identify problem before turning to chapter 6 for its adjustment, repair, or replacement procedure. Carefully read entire procedure and assemble all tools and fixtures necessary to perform work before proceeding.

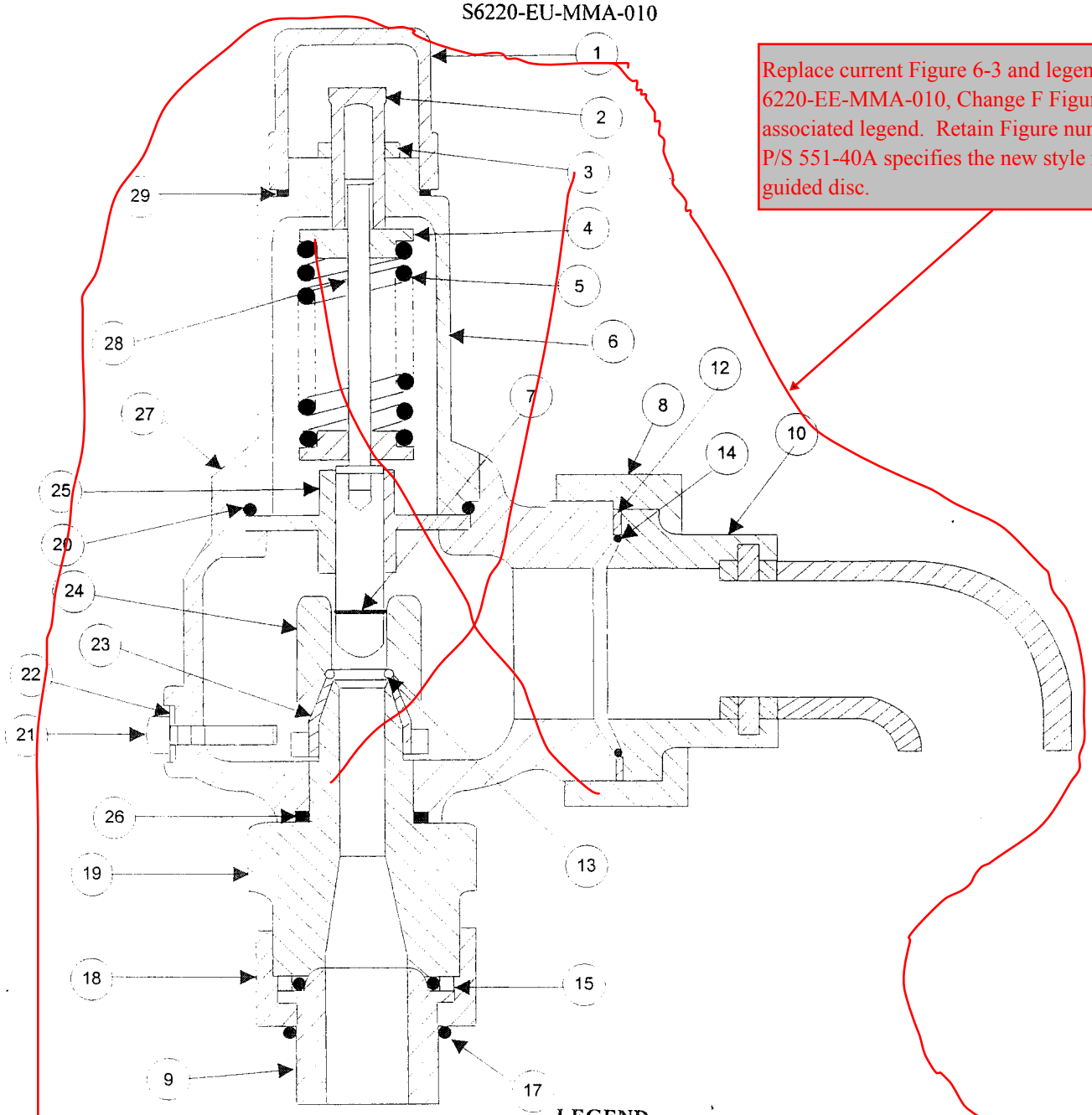
6-5.2 Work Area. Arrange a clean, well-lighted bench top for working on any assemblies such as valves, switches, electrical components, etc. Avoid nicking or scratching any machined surfaces by handling parts with care and be sure to mark or tag all disassembled pieces to ensure proper replacement. Remove all screws and bolts counter-clockwise unless otherwise specified.

ON

To prevent contamination of piping and components with dirt and foreign matter, ensure that all openings are covered with pressure-sensitive tape.

Cleanliness in the handling and reassembly of parts is of the utmost importance. Small particles of dirt or grit allowed to remain on parts being assembled or allowed to fall into or remain in the compressor can cause scuffed bearings, rapid wear of mating elements, or other serious damage. When any RTD's, switches, gauges, or filters are removed from the unit, be sure to cover the opening to avoid possibility of internal contamination.

Replace current Figure 6-3 and legend with T/M 6220-EE-MMA-010, Change F Figure 6-3.2 and its associated legend. Retain Figure number 6-3. Re: P/S 551-40A specifies the new style relief with a stem guided disc.



LEGEND

1. HOOD
2. PRESSURE SCREW
3. LOCKNUT
4. SPRING PLATE
5. SPRING
6. BONNET
7. SNAP RING
8. UNION NUT
9. TAILPIECE
10. ELBOW
11. O-RING
12. RETAINER RING
13. SEAT RING
14. O-RING
15. RETAINER RING
16. TAILPIECE
17. O-RING
18. UNION NUT
19. BASE
20. O-RING
21. SET SCREW
22. GASKET
23. REGULATOR RING
24. DISC
25. GUIDE
26. O-RING
27. BODY
28. STEM ASSEMBLY
29. GASKET

Figure 6-3. High Pressure Relief Valve

6-5.4 Tools. For the most part, standard mechanics hand tools can be used for repairing and maintaining the compressor unit. In those instances where more specialized tools are required, specific information is given in the description of the operation involved.

6-5.5 Cleaning. In a well-ventilated area, wash all non-electrical metal parts with a mineral-base cleaning solvent using the following procedures:

CAUTION

To prevent damage to equipment, do not allow machined or lapped mating surfaces to contact any surface without protection against nicks, scratches, and burrs.

NOTE

Do not use solvents in protected CPS zones.

a) Pay special attention to o-ring grooves, threads, internal passages, and bores. Use a stiff-bristled brush to remove hardened deposits of dirt or other contaminants.

b) Remove grease, oil, or dirt from exterior surfaces with an approved water-soluble detergent and water.

c) Rinse bearings in hydraulic fluid. Allow bearings to air dry. Wrap bearings individually in clean oil-paper.

d) After cleaning, dry parts other than bearings thoroughly.

e) Refer to Naval Ships Technical Manual (NSTM) chapters 300, 302, and 320 for cleaning procedures on electrical components.

6-5.6 Inspection. Using a strong light and magnification, visually inspect all components other than parts such as the main rotor or gate rotor shafts, as follows:

a) Inspect all parts for excessive wear, deformation, or deterioration of parts that may render them unserviceable.

b) Check all parts for evidence of fractures, corrosion, and discoloration caused by overheating.

c) Examine areas adjacent to threads and bends for cracks.

d) Inspect threaded areas for stripped threads and evidence of cross-threading.

e) Inspect bearings for flat spots and corrosion to ensure smooth, free operation.

f) Check all springs for cracks, bends, and uniform expansion and retraction ability.

g) Inspect nonmetallic hoses for crazing, checking, cracks, splits, and tears, particularly adjacent to fittings and in area of clamping devices.

h) Check water and air piping for leaks.

6-5.7 Common Repair Procedures. Repair parts in accordance with standard shop practices, using standard shop tools. Minor repairs to precision machined parts may be accomplished if fits and clearances are maintained and the reliability of the part is not adversely affected. To repair parts, proceed as follows:

a) Remove light surface discoloration from bare metal surfaces, using a cloth saturated with liquid metal polish. Remove discoloration by rubbing briskly, then polish with a clean, dry, lint-free cloth. Clean parts (IAW paragraph 6-5.5).

b) Remove corrosion from metal surfaces by polishing with crocus cloth, grit 400, and polish (IAW step a. above).

c) Remove minor nicks and scratches from metal surfaces by polishing with crocus cloth, grit 400. Blend out edges of reworked area, and polish (IAW step a. above).

d) If rework is required on a mating surface, finish-lap using a lapping machine or block.

e) Break all sharp edges after lapping, using a rubberized abrasive stick for parts made from nonferrous metals or a fine India stone for parts made from ferrous metals.

f) Wash any lapping compound from parts.

6-5.8 Water Management System Repair. Repairs to the piping and tubing may be accomplished at the shipboard level. NSTM Chapter 505 (9480) may be referenced for piping systems. Joint design, non-destructive testing, and certification requirements shall be in accordance with NSTM Chapter 074. In addition, all military specifications and standards that apply must be followed. Maintenance personnel must be thoroughly familiar with the Safety Summary and all Warnings and Cautions that apply.

6-5.9 Replacement. Replace parts in accordance with standard shop practices, using standard shop tools as follows:

a) Replace all parts not meeting inspection requirements and not within allowable wear limits.

b) Replace any parts that show discoloration from overheating.

c) If the serviceability of any part is questionable, replace the part.

d) Replace all o-rings, seals, gaskets, and packing during reassembly. The used items should not be discarded until the availability of replacement parts is determined. If replacement parts are not available, and equipment must be reassembled due to ship's mission or other emergency, the used o-rings, seals, gaskets, and packing may be reused. If old parts must be reused, the system should be loosely checked for leaks.

6-6. COMPRESSOR REPAIR PROCEDURES.

Table 6-1 contains common torque values for use when replacing LPAC parts. These values are to be used unless a specific torque value is indicated in the procedure.

6-6.1 Repairing High Pressure Relief Valve.

6-6.1.1 Removal/Replacement of High Pressure Relief Valve. (Index numbers below refer to Figure 6-3 unless otherwise indicated.) This procedure is to be used for both the high-pressure relief valve (2, Figure 2-2) on the separator and the air-end relief valve (2, Figure 6-4).

WARNING

To avoid harm to personnel, LPAC must not be started with relief valve loose or removed.

a) Ensure **MAN/AUTO** selector switch (4, Figure 2-1) set to **MAN**.

b) If LPAC is running, press **STOP/RESET** pushbutton switch (7, Figure 2-1).

c) Turn OFF and lock-out main LPAC power source. Install **OUT-OF-SERVICE** tag.

WARNING

Compressed air is dangerous. Ensure air end separator tank is at atmospheric pressure prior to starting removal of relief valve.

d) Unscrew high-pressure relief valve (2, Figure 2-2) from its parent assembly.

e) Remove o-ring (17) from tailpiece (16).

f) If high-pressure relief valve has been disassembled, calibrate (IAW paragraph 6-3.1).

g) To replace, install new o-ring (17) on tailpiece (16) and reinstall the valve.

6-6.1.2 Disassembly/Reassembly of Valve. (Index numbers below refer to Figure 6-3 unless otherwise indicated.)

a) Remove high-pressure relief valve (2, Figure 2-2, IAW paragraph 6-6.1.1).

NOTE

Disassemble valve only to point necessary to replace faulty parts. Reverse procedure from that point to reassemble valve. Reinstall valve (IAW 6-6.1.1).

b) Unscrew high-pressure relief valve from union nut (18), remove o-ring (14), and retainer ring (15).

c) Unscrew hood (1) and gasket (29) from high-pressure relief valve.

d) Mark pressure screw (2) position on bonnet (6).

e) Loosen locknut (3) and back-out pressure screw (2), recording number of turns.

f) Unscrew bonnet (6) from body (27).

g) Lift off spring plate (4) and remove spring (5).

h) Remove o-ring (26) and guide (25).

i)

Delete step l and re alphabetize subsequent steps. Re: There is no adjustment ring on a stem guided valve.

j) assembly (28).

k) Remove set screw (21) and gasket (22).

l) Unscrew regulator ring (23).

m) Unscrew body (27) from base (19) and remove o-ring (20).

n) Unscrew union nut (8), and remove tailpiece (9), o-ring (11), and retainer ring (12).

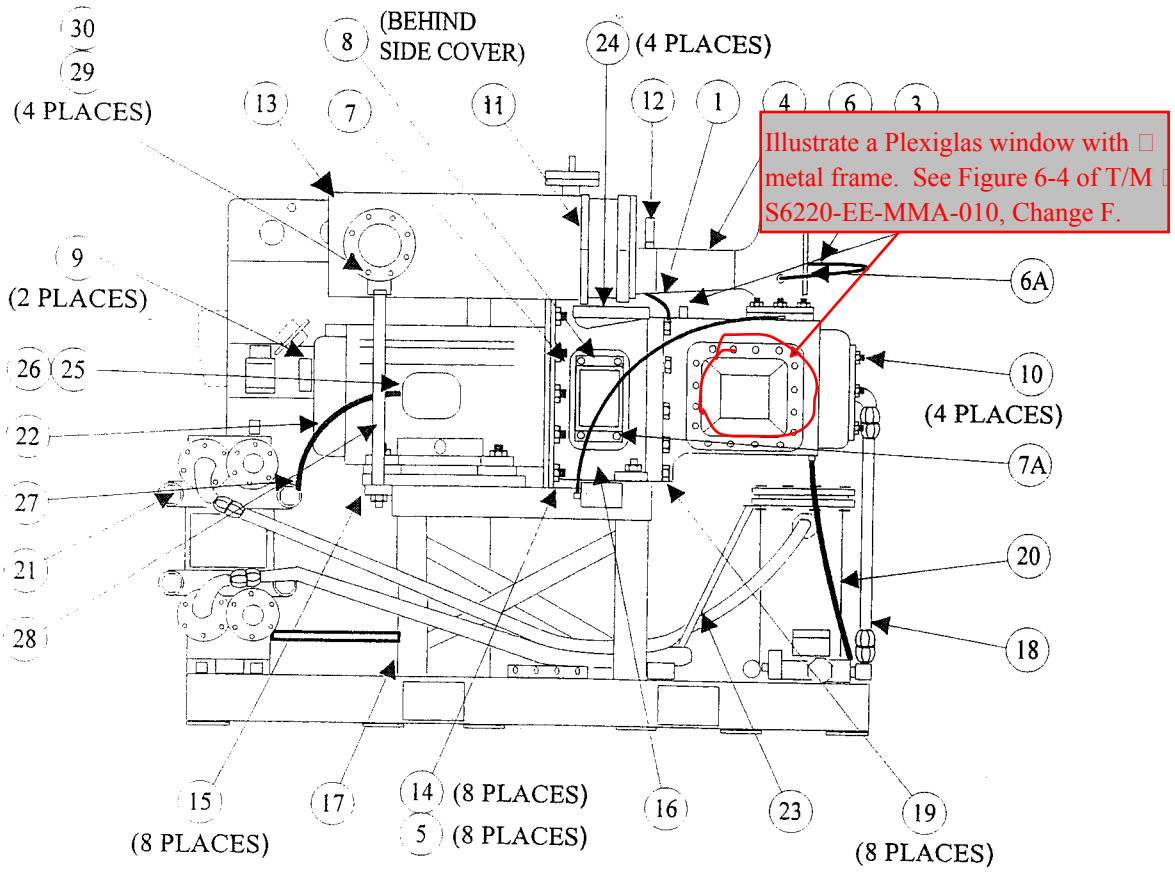
o) Inspect all components for excessive wear, nicks, distortion, or other damage. Replace faulty items.

p) Reverse order above to reassemble high-pressure relief valve (2, Figure 2-2), installing new o-rings and gaskets.

Table 6-1. Torque Values for Grade 5 Bolts and Studs

SIZE	THREADS PER INCH	FT. LBS. TORQUE*	+ FOR ESNA NUT
1/4 INCH	20	4	0
5/16 INCH	18	8	0
3/8 INCH	16	15	0
3/8 INCH	24	18	0
7/16 INCH	14	24	0
1/2 INCH	13	38	15 FT. LBS.
5/8 INCH	11	76	35 FT. LBS.
3/4 INCH	10	136	50 FT. LBS.
7/8 INCH	9	220	75 FT. LBS.
1 INCH	8	332	100 FT. LBS.

* Based on lubricated threads pre-stressed to 40,000 pounds per square inch.



LEGEND

1. SEAL VENT LINE
2. RELIEF VALVE
3. UNLOADER VALVE AIR LINE
4. SUCTION UNLOADER VALVE HOSE
5. STUD
6. SUCTION UNLOADER VALVE
6A. MOUNTING NUTS
7. DISTANCE PIECE SIDE COVER AND FILTER
7A. MOUNTING NUTS
8. DRIVE COUPLING
9. DRIVE MOTOR
10. COMPRESSOR ASSEMBLY
11. FILTER HOLD-DOWN STRAPS
12. PRESSURE DROP INDICATOR
13. AIR INLET FILTER ASSEMBLY
14. MOUNTING NUTS
15. DRIVE MOTOR MOUNTING NUTS (REFERENCE)
16. DISTANCE PIECE
17. DRIVE MOTOR BASE
18. INJECTION WATER LINE
19. MOUNTING NUTS
20. WATER FILTER ASSEMBLY
21. HEAT EXCHANGER ASSEMBLY
22. WIRING HARNESS
23. SUPPORT BRACKET
24. SPACER
25. BUSHING
26. CONDUIT FITTING
27. MYERS HUB
28. BRACKET
29. STUD
30. NUT

Figure 6-4. LPAC Rear View

6-6.2 Repair/Reconditioning Suction Unloader Valve.

6-6.2.1 Removal/Replacement of Suction Unloader Valve. (Index numbers below refer to Figure 6-4 unless otherwise indicated.)

WARNING

To avoid harm to personnel, LPAC must not be started with valve loose or removed.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Ensure **MAN/AUTO** selector switch (4, Figure 2-1) is set to **MAN**.

b) If LPAC is running, press **STOP/RESET** pushbutton switch (7, Figure 2-1).

c) Turn OFF and lock-out main LPAC power source. Install OUT-OF-SERVICE tag.

WARNING

To avoid harm to personnel, ensure LPAC compressor assembly is at atmospheric pressure before disconnecting.

d) Loosen unloader valve air line (3) connected to side of suction unloader valve and bleed off any residual air pressure. When all residual pressure is released, remove both unloader valve air lines (3).

e) Disconnect air inlet to suction unloader valve hose (4) at suction unloader valve end.

f) Remove six unloader valve mounting nuts (6A) and Lift off suction unloader valve (6) and place on suitable work surface. Cover openings with pressure sensitive tape to prevent contamination.

NOTE

Do not use any sealant on the gasket.

g) Use a new unloader-to-housing gasket (20, Figure 6-6) and reverse above steps to reinstall suction unloader valve (6) on compressor assembly (10).

h) Remove OUT-OF-SERVICE tag and restore main source power to LPAC.

6-6.2.2 Disassembly/Reassembly of Suction Unloader Valve. (Index numbers below refer to Figure 6-5 unless otherwise indicated.)

NOTE

Disassemble suction unloader valve (6, Figure 6-4) only to point necessary to replace faulty parts. Reverse procedure from that point to reassemble valve. Reinstall suction unloader valve (6, Figure 6-4, IAW paragraph 6-6.2.1).

a) Remove valve (IAW paragraph 6-6.2.1).

b) Match mark dia[Make "diaphram" plural.]on unloader valve housing (18).

[Insert "both".] even cover bolts (2) and remove diaphragm cover (3) from suction unloader valve housing (18).

d) Remove diaphragm (4).

e) Remove and check valve plunger (5), return spring (6) and main spring (7) and check both springs for breaks or loss of tension.

f) Holding valve (11), remove cap screw (8) and washer (9) from inlet throat of suction unloader valve housing (18).

g) Slide spring retainer (10), valve (11), valve gasket (12), valve shaft (13), and retainer ring (14) out of rear of housing (18).

h) Remove retaining ring (14) from valve (11) and remove bearing (15).

i) Remove plug (16) and o-ring (17) from housing (18).

j) Inspect all parts for wear, holes, or corrosion.

NOTE

When replacing diaphragm (4) on diaphragm cover (3), thread a couple of cover bolts (2) through holes to keep parts together until the cover is replaced on suction unloader valve housing (18).

NOTE

When installing diaphragm cover (3), torque cover bolts (2) to 15 ft. lbs.

k) Reassemble in reverse order of above, replacing any defective parts. Install new o-ring (17) and valve gasket (12).

l) Reinstall suction unloader valve (6, Figure 6-4) on compressor assembly (10, Figure 6-4, IAW paragraph 6-6.3.1).

m) Ensure suction unloader valve (6, Figure 6-4) unloads LPAC to approximately 50 psig per table 2-3.

6-6.3 Servicing Air-End Check Valve. (Index numbers below refer to Figure 6-6 unless otherwise indicated.)

6-6.3.1 Removal/Replacement of Air-End Check Valve.

WARNING

To avoid harm to personnel, LPAC must not be started with check valve loose or removed.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to loss of power and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

b) If LPAC is running, press **STOP/RESET** pushbutton switch (7, Figure 2-1).

c) Turn OFF and lock-out main LPAC power source. Install OUT-OF-SERVICE tag.

d) Disconnect high temperature shut-down switch (12) lead by hand.

WARNING

Compressed air is dangerous. Always vent any residual air pressure before working on or disconnecting pressure piping.

CAUTION

To prevent damage, ensure check valve assembly does not fall to deck when last mounting nut removed.

NOTE

Be prepared for residual water when loosening and removing air-end discharge line.

e) Remove four mounting nuts (3).

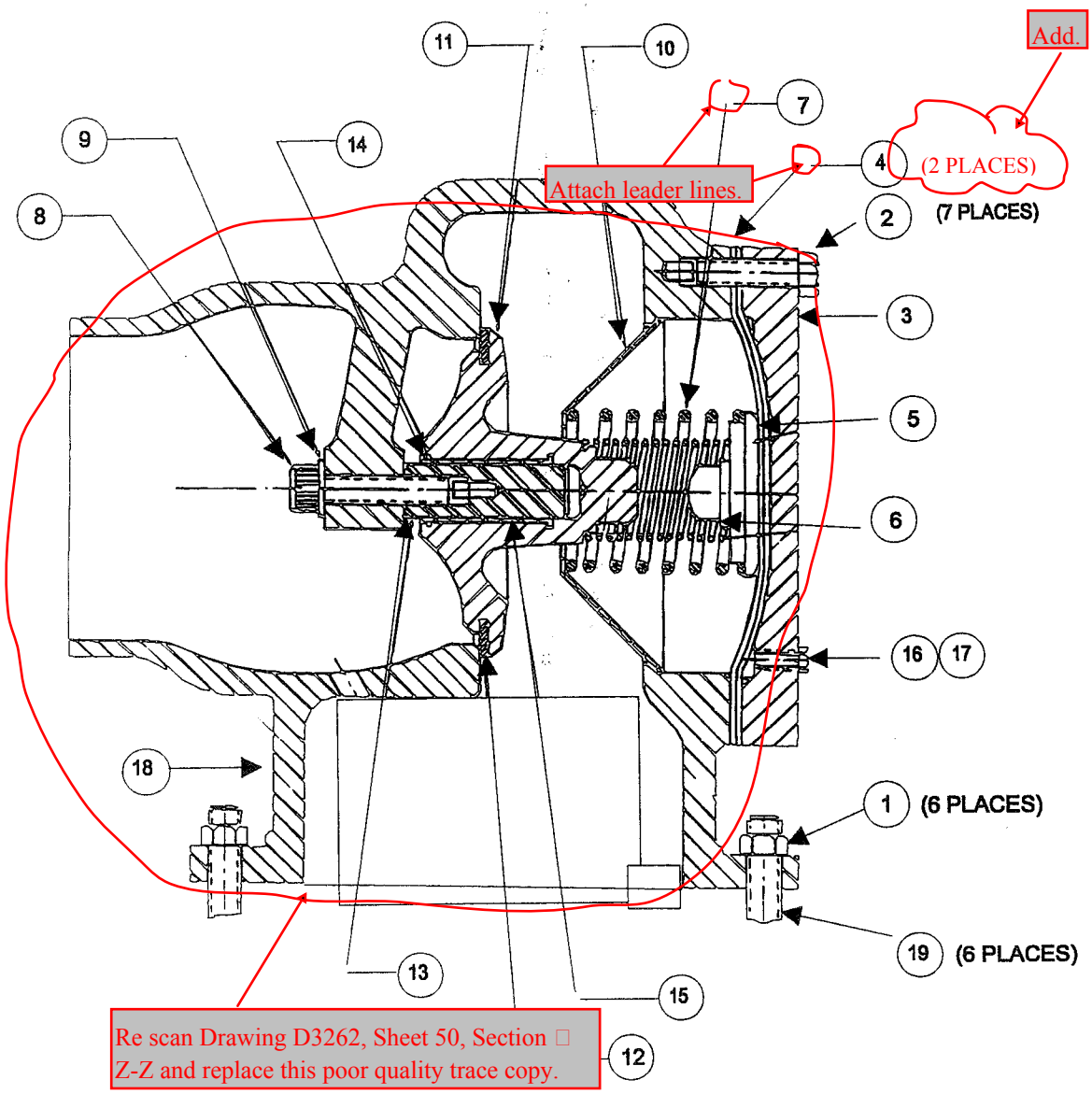
f) Loosen air-end discharge line at flanged elbow (4) enough to vent residual air pressure from compressor assembly (10, Figure 6-4). When all pressure vented, remove line.

g) Mark side of air-end check valve assembly (1) with arrow showing direction of air flow (arrow should point down). This will ensure check valve is reinstalled correctly.

h) Remove check valve and gaskets (5) and (11).

WARNING

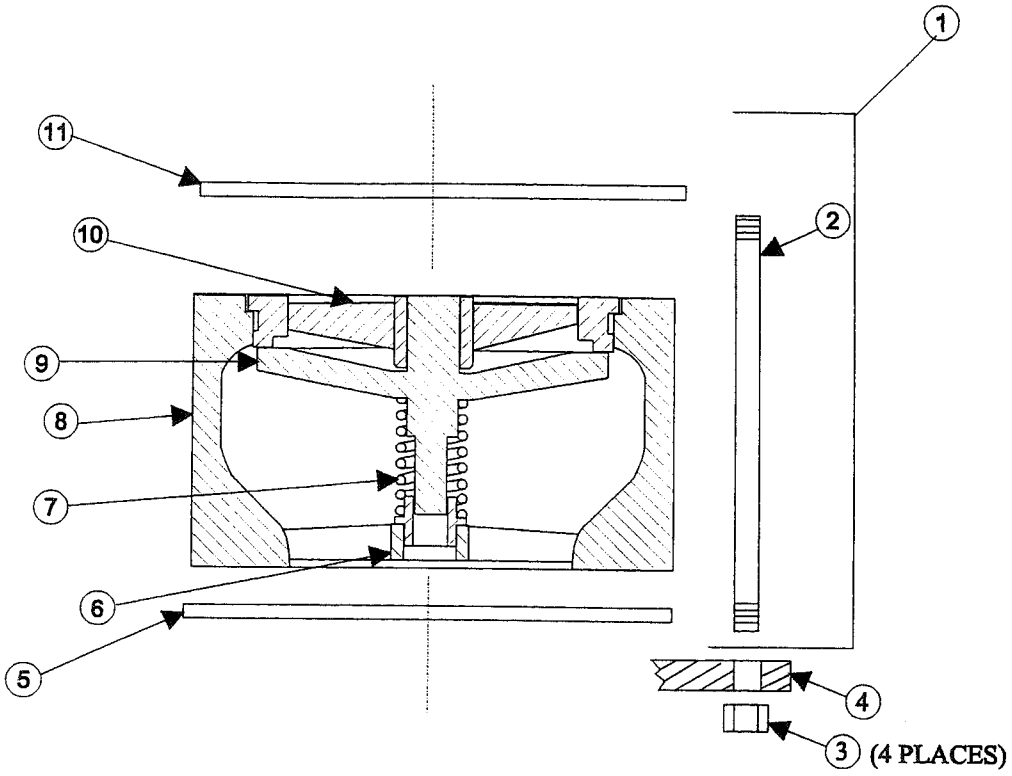
Sealant will irritate skin and eyes and harmful if swallowed. Avoid contact with skin and prolonged breathing of vapors.



LEGEND

1. MOUNTING NUTS
2. COVER BOLTS
3. DIAPHRAGM COVER
4. DIAPHRAGM
5. CHECK VALVE PLUNGER
6. SPRING (RETURN)
7. SPRING (MAIN)
8. CAP SCREW
9. WASHER
10. SPRING RETAINER
11. VALVE
12. VALVE GASKET
13. VALVE SHAFT
14. RETAINING RING
15. BEARING
16. PLUG
17. O-RING
18. SUCTION UNLOADER VALVE HOUSING
19. STUD
20. UNLOADER-TO-HOUSING GASKET

Figure 6-5. Suction Unloader Valve



LEGEND

1. AIR-END CHECK VALVE ASSEMBLY
2. STUD
3. MOUNTING NUTS
4. FLANGED ELBOW (REFERENCE)
5. GASKET
6. BUSHING
7. SPRING
8. BODY
9. PLUG
10. SEAT
11. GASKET

Figure 6-6. Air End Check Valve

NOTE

Apply "Perma-Lok" sealant, FSCM 85091, p/n HH190, or equivalent, to all air-end gaskets prior to installation.

i) Reinstall air-end check valve by reversing steps above. Use new gaskets (5 and 11). Ensure check valve is installed with arrow described in step g. above pointing down.

j) Torque check valve mounting nuts to 40-45 ft. lbs.

k) Remove OUT-OF-SERVICE tag and restore main power to LPAC.

l) Upon start-up and subsequent operation, note whether air-end check valve is functioning properly.

6-6.3.2 Disassembly/Reassembly of Air-End Check Valve. (Index numbers below refer to Figure 6-6.)

a) Remove air-end check valve assembly (1)(IAW paragraph 6-6.3.1 above).

b) Disassemble air-end check valve (1) at workbench, avoiding contaminating or nicking any internal parts.

c) Turn air-end check valve (1) to rest on outlet face with inlet face upward. Use spanner to unscrew seat (10) and remove.

d) Remove plug (9), spring (7), and bushing (6) from body (8).

e) Carefully clean and examine lapped surfaces between piston parts for wear or damage, spring (7) for loss of tension or broken parts, and bushing (6) for excessive wear.

f) Reassemble by inserting bushing (6), spring (7), plug (9), and install seat (10) until it bottoms out and is flush with top of body (8).

g) Reinstall air-end check valve (1) on compressor housing (IAW paragraph 6-6.3.1).

6-6.4 Repair of Gate Rotors. (Index numbers below refer to Figure 6-7 unless otherwise indicated.)

NOTE

It is recommended that repair/ maintenance work done on compressor assembly (10, Figure 6-4) be performed at a depot level. Special tooling and handling is required and unless shipboard personnel have specific training this work must not be attempted on the ship. If it is necessary it may be possible to work on gate rotor assemblies which do not require special tooling, but there are still clearances that need to be set for the gate rotor assembly and between the gate rotor and the housing. Personnel must be trained to properly set-up gate rotor assembly.

6-6.4.1 Removal/Disassembly of Gate Rotors.

WARNING

To avoid harm to personnel, LPAC must not be energized while working on internal components.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the last mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

b) If LPAC is running, press **STOP/RESET** pushbutton switch (7, Figure 2-1).

WARNING

To avoid harm to personnel, LPAC must not be energized while working on internal components.

c) Turn OFF and lock-out main LPAC power source. Install OUT-OF-SERVICE tag.

To illustrate and account for an unloader gasket, gate rotor shims, windows and gaskets, accomplish the following ;
1). Delete this figure and Substitute with T/M S6220-EE-MMA-010 Change F, Figure 8-8.1, Sheets 1 and 2.
2). Retain current Figure number 6-7.
3). Ensure paragraphs 6-6.4.1 to 6-6.5 text and index numbers match the new figure. Refer to T/M S6220-EE-MMA-010 Change F.

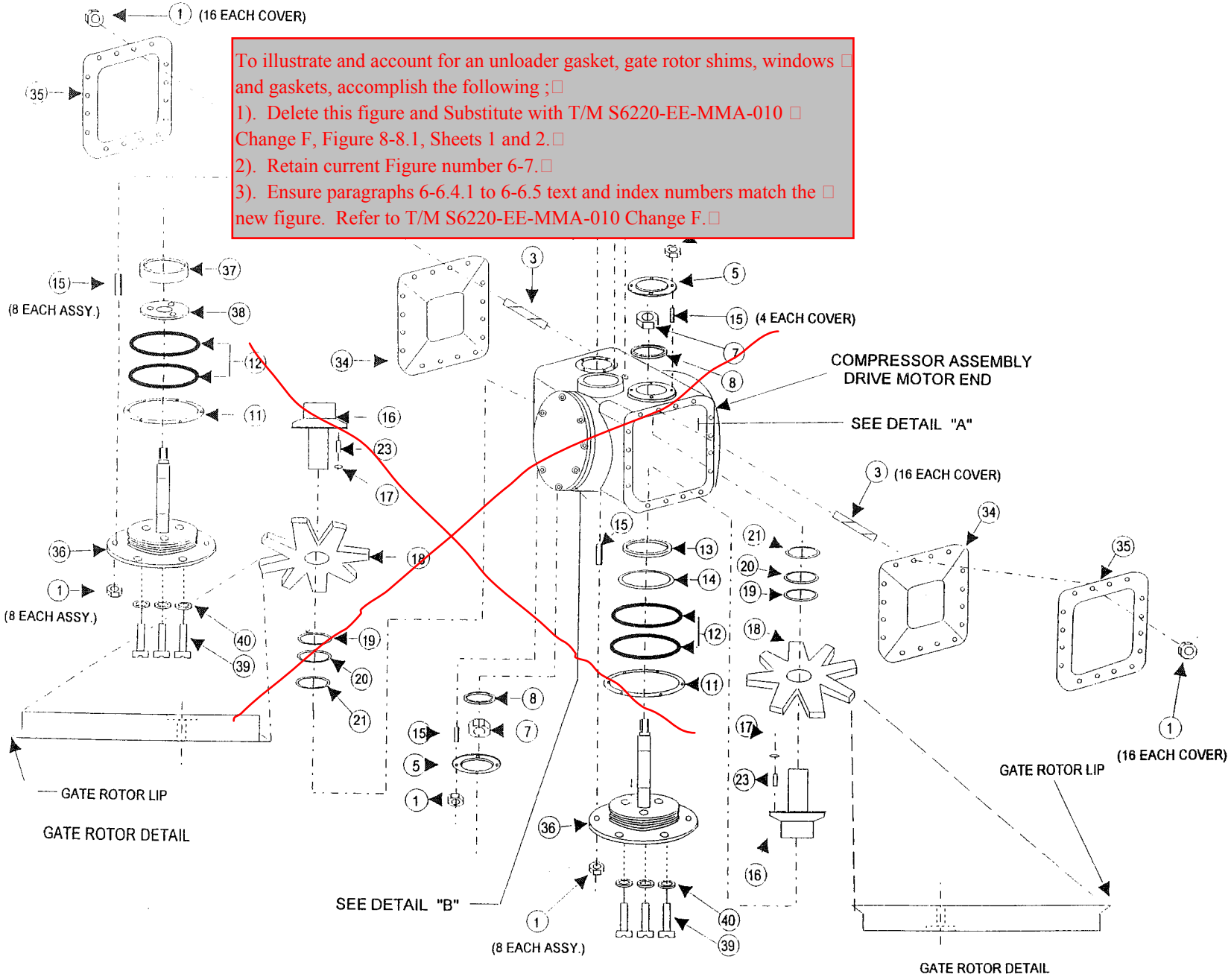
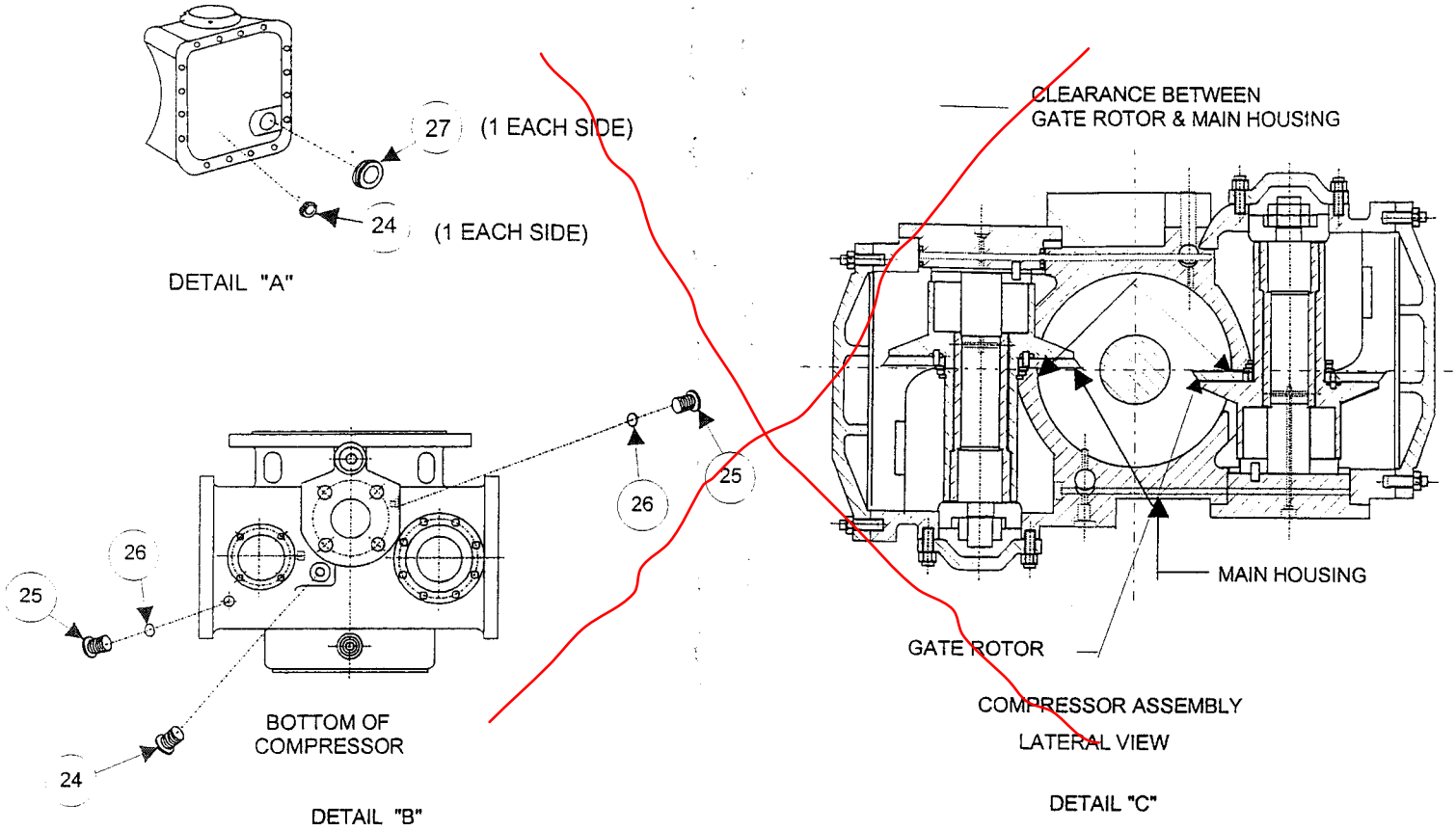


Figure 6-7. Gate Rotor Assemblies (sheet 1 of 2)

See previous comment on Figure 6-7, Sheet 1.



LEGEND

1. SIDE COVER NUT, FREE-END HOUSING COVER NUT, GATE ROTOR SHAFT ASSEMBLY MOUNTING NUT
2. (DELETED)
3. STUD
4. NOT USED
5. FREE-END HOUSING COVER
6. NOT USED
7. GATE ROTOR SHAFT NUT
8. FREE-END WASHER
9. NOT USED
10. (DELETED)
11. GATE ROTOR SHAFT SHIMS
12. SHAFT ASSEMBLY O-RING
13. (DELETED)
14. (DELETED)
15. STUD
16. GATE ROTOR SUPPORT
17. O-RING
18. GATE ROTOR
19. RETAINING RING
20. WAVE SPRING
21. SNAP RING
22. (DELETED)
23. GATE ROTOR LOCATING BOLT
24. PIPE PLUG
25. FITTING
26. O-RING
27. PIPE PLUG
28. GASKET, FREE-END COVER
29. GASKET, SIDE COVER (NOT SHOWN)
30. O-RING (NOT SHOWN)
31. FITTING (NOT SHOWN)
32. O-RING
33. FITTING
34. WINDOW
35. WINDOW FRAME
36. GATE ROTOR SHAFT ASSEMBLY
37. THRUST-END WASHER
38. THRUST-END WASHER SHIMS
39. CAPSCREW (NOT SHOWN)
40. WASHER (NOT SHOWN)

Figure 6-7. Gate Rotor Assemblies (sheet 2 of 2)

WARNING

Compressed air is dangerous. Always vent any residual air pressure before starting disassembly of compressor.

NOTE

Be prepared for residual water when loosening air-end side covers.

d) Remove sixteen side cover nuts (1) and side cover (2). If metal cover is installed, use two 3/8"-16 threaded bolts to jack side cover (2) off studs (3). If plastic window is installed, remove frame (35) and window (34). Repeat to remove other side cover, if necessary.

NOTE

Depending on which of two towers is being serviced, the free-end of gate rotor shaft assembly (10) can be either at top or bottom of compressor assembly. Free-end housing cover (5) is smaller of two covers.

e) Remove four free-end housing cover nuts (1). Use a 3/8"-16 threaded bolt to jack free-end housing cover (5) from studs (15) and expose gate rotor shaft nut (7).

CAUTION

To prevent damage to gate rotor machined surfaces, ensure that gate rotor assembly does not fall to deck when mounting nuts removed.

f) Remove gate rotor shaft nut (7) and free-end washer (8).

g) Remove eight gate rotor shaft assembly mounting nuts (1).

h) Lift gate rotor shaft assembly (10) or (36); gate rotor shaft shims (11); two, shaft assembly o-rings (12); thrust-end washer (13) or (37); and thrust-end washer shims (14) or (38); as an assembly, from studs (15) by tapping with a lead mallet from free-end of tower.

NOTE

Do not remove shims from under flange, unless they have been damaged and replacement is required.

i) If bolted thrust washer is installed, remove capscrews (39) and washers (40). Remove thrust-end washer (13) or (37) from gate rotor shaft assembly.

CAUTION

Tilting and twisting should be done without force. When looking into gate rotor compartment, ensure that thrust-end of gate rotor assembly moves first to enable disengagement of gate tooth from main rotor flute.

j) Using side opening of compressor assembly, employ a slight tilting and twisting motion to disengage gate teeth from flutes of main rotor. Remove, as an assembly: gate rotor support (16); o-ring (17); gate rotor locating bolt (23); gate rotor (18); retaining ring (19); wave spring (20); and snap ring (21).

NOTE

It may require a screwdriver to remove snap ring (21) from groove of gate rotor support (16).

k) Once gate rotor assembly has been removed and placed thrust-end downward on a clean, resilient surface, remove snap ring (21); wave spring (20); and retaining ring (19) from gate rotor support (16).

l) Lift gate rotor (18) off gate rotor support (16).

m) Remove gate rotor locating bolt (23) and o-ring (17).

n) Repeat steps d. through m. above for other gate rotor tower, if necessary.

o) Remove four pipe plugs (24), two fittings (25) with o-rings (26), two pipe plugs (27), and three fittings (33) with o-rings (32).

6-6.4.2 Reassembly/Replacement of Gate Rotors. (Index numbers below refer to Figure 6-7 unless otherwise indicated.)

a) Set gate rotor support (16) (with upper and lower bearings in place) large-end down on a clean, soft surface. Avoid scratching carbon bearings.

b) Check that all surfaces are clean and corners deburred.

NOTE

Very little Loctite #271 should be used. Avoid getting liquid between gate rotor (18) and gate rotor support (16).

c) Install gate rotor locating bolt (23) into gate rotor support (16). Use Loctite # 271 on threads to avoid loosening during operation. Torque bolt to value shown in table 6-1.

d) Install o-ring (17) onto gate rotor locating bolt (23) using silicone grease on o-ring to ease assembly.

NOTE

Thrust surface of gate rotor is one with a lip at outer diameter (Detail C, Figure 6-7). Before proceeding, ensure that gate rotor is facing properly.

e) With thrust surface upwards, slide gate rotor (18) down over gate rotor support (16) and position on gate rotor locating bolt (23). Ensure counter bore of gate rotor (18) locating hole is facing toward gate rotor support (16) and that lower edge of hole is deburred to avoid cutting o-ring (17).

f) Install retaining ring (19) as follows:

1) Work retaining ring (19) down over gate rotor support (16) until it seats flush against gate rotor (18).

2) Relieve tension of wave spring (20) to aid in sliding it down into position atop retaining ring (19).

NOTE

Use a screwdriver to snug snap ring (21) down into groove of gate rotor support (16).

3) Install snap ring (21) making sure it seats securely in gate rotor support (16) groove.

g) Ensure that gate rotor shaft assembly (10) is clean, and place it on a clean surface, centered over a .75" hole.

h) If using bolted thrust washer, there is no locating pin. If old pin is damaged, press new locating pin (22) into hole in the gate rotor shaft assembly (10) flange.

i) Slide thrust-end washer (13) or (37) over gate rotor assembly (10) or (36) shaft and seat against shaft flange. Ensure locating pin (22) fits in blind hole on thrust-end washer back if thrust-end washer (13) is used.

j) Slide gate rotor support (16) assembly, complete with gate rotor (18) and rings (19, 20, and 21), over gate rotor shaft assembly (10) or (36) and down against thrust-end washer (13) or (37).

k) Install free-end washer (8) on end of gate rotor shaft assembly (10) or (36).

NOTE

Substitute a 7/8-9 UNC nut for next operation.

l) Finger tighten a loosely fitting nut on the shaft thread. Save nylon-insert gate rotor shaft nut (7) for final assembly in compressor housing.

m) Set gate rotor shaft assembly (10) or (36) gate rotor support (16) running clearance as follows:

NOTE

All shims used on compressor have color-coding to indicate thickness of shim.

Silver = .0005" Thick	Blue = .005" Thick
Amber = .001" Thick	Brown = .010" Thick
Red = .002" Thick	White = .025" Thick

1) Measure minimum clearance between free-end-washer (8) and carbon bushing at top of gate rotor support (16), using a feeler gauge. Subtracting .001", select an equivalent amount of thrust-end washer shims (14) or (38).

2) Take assembly apart and install selected thrust-end washer shims (14) or (38) under thrust-end washer (13) or (37). If bolted thrust washer is being used, align holes in shims (38) and tapped holes in thrust washer (37) over the holes in the gate rotor cover. Position capscrew (39) with washers (40) through gate rotor cover into thrust-end washers (13) or (37). Tighten capscrews (39) and torque to 8 ft.-lbs.

3) Reassemble, using a torque value of 40 ft. lbs. to tighten temporary shaft nut.

4) Ensure that a .001" feeler gauge fits loosely between free-end washer (8) and carbon bushing at end of gate rotor support (16), all around. A .0015" feeler gauge should fit tightly in tight spots. If necessary, add or subtract shims until proper clearance is obtained.

CAUTION

Installation of gate rotor assembly must be accomplished without force of any kind to ensure that leading edges of gate rotor (18) are not damaged.

NOTE

Ensure full main rotor flute opening is available at position where gate rotor tooth is to be entered. Move main rotor backward or forward slightly as gate rotor assembly is slid into position. When correctly positioned, gate rotor assembly will set perfectly vertical and centered in tower, and gate rotor tooth will be fully entered into a main rotor flute.

n) Install gate rotor shaft assembly (10) or (36) into compressor housing as follows:

1) Remove temporary gate rotor shaft nut (7), free-end washer (8) and gate rotor support (16) from gate rotor shaft assembly (10) or (36). Leave thrust-end washer (13) or (37) and thrust-end washer shims (14) or (38) on gate rotor shaft assembly (10) or (36) shaft.
2) Install gate rotor support (16), with gate rotor (18) attached, into compressor housing with a slight tilt and a twist in reverse order of its removal.

NOTE

Do not place shaft assembly o-ring (12) on gate rotor shaft assembly (10) or (36) until final installation into compressor housing.

3) With one hand, hold gate rotor support (16) in compressor housing. With other hand, slide the gate rotor shaft assembly (10) or (36) into housing and gate rotor support (16) until thrust-end washer (13) or (37) touches gate rotor support (16).

NOTE

Check constantly, ensuring gate rotor support (16) rotates freely while tightening gate rotor shaft nut (7).

4) Install free-end washer (8) and temporary gate rotor shaft nut (7).
5) Push gate rotor shaft assembly (10) or (36) into housing until it seats against the housing surface. Tap shaft assembly with small piece of lead if necessary. Trying to rotate gate rotor support (16) gives a good indication whether or not the gate rotor shaft assembly (10) or (36) is seated in the housing. Torque nut to 10 ft. lbs.
6) Measure clearance between gate rotor shaft assembly (10) or (36) flange and housing. Add .002" to measurement and select a corresponding amount of gate rotor shaft shims (11).

NOTE

All shims used on compressor have color coding to indicate thickness of shim:

COLOR	THICKNESS
Silver	.0005"
Amber	.001"
Red	.002"
Blue	.005"
Brown	.010"
White	.025"

7) Remove gate rotor shaft assembly (10) or (36) from housing and install selected gate rotor shaft shims (11) on studs (15).
8) Reinstall gate rotor shaft assembly (10) or (36) in housing and install four gate rotor shaft assembly mounting nuts (1) finger tight.
9) Ensure gate rotor support (16) turns freely, then torque mounting nuts (1) to 15 ft. lbs. and shaft nut (7) to 40 ft. lbs.
10) Using a feeler gauge, measure the running clearance between gate rotor (18) and compressor assembly housing (refer to Figure 6-7, Detail "C"). Check all gate rotor teeth. A .002" feeler gauge should fit loosely between gate rotor (18) and housing. A .0025" feeler gauge should not fit or fit rather tightly. If necessary, add or subtract shims until proper clearance is obtained.
11) Remove gate rotor shaft assembly (10) or (36), install two shaft assembly o-rings (12), line up water hole and reinstall with eight nuts (1) on studs (15). Torque to 15 ft. lbs.

NOTE

Before installing a new gate rotor shaft nut (7), pass a 7/8-9UNC tap through the nut in order to tap the nylon insert. If this is not done, the nylon may deform the threads on the shaft and problems could be created when disassembly is attempted.

12) Install gate rotor shaft nut (7) and torque to 40 ft. lbs.

NOTE

Do not use any sealant on the gasket.

o) Check gate rotor assembly for freedom of rotation. If gate rotor assembly does not rotate freely, shims may not be adequate to provide clearance for free rotation. If rotation is not free, go back to step n. (6) above. If assembly rotates freely, replace free-end housing cover (5) with a new free-end cover gasket (28).

NOTE

There is a letter (A or B) stamped on the housing location for the gate rotor assembly. If a new gate rotor assembly is being installed, stamp or scribe the same letter on the gate rotor cover flange.

p) Install four free-end housing cover nuts (1 torque to 15 ft. lbs.

q) Clean side cover (2) or window (34) mating surfaces.

NOTE

Do not use any sealant on the side-cover gasket (29).

r) Install a new side-cover gasket (29) side cover (2) or window (34) window frame (35) and sixteen side-cover nuts (1). Torque nuts to 15 ft. lbs.

s) Repeat steps a. through r. above for other gate rotor tower, if necessary.

t) Install four pipe plugs (24), two fittings (25) with new o-rings (26), two pipe plugs (27), and three fittings (33) with o-ring (32).

u) Restore main power to LPAC and remove C

v) Check wo LPAC is

Delete. Substitute with steps from T/M S6220-EE-MMA-010 Change F para. 6-6.6.1.j (for the Rexnord coupling).

6-6.5 Repair of Drive Coupling. (Index numbers below refer to Figure 6-8 unless otherwise indicated.)

6-6.5.1 Removal/Replacement of Drive Coupling.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

b) If LPAC is running, press **STOP/RESET** pushbutton switch (7, Figure 2-1).

WARNING

To avoid harm to personnel, LPAC must not be energized while working on internal components.

c) Turn OFF and lock-out main LPAC power source. Install OUT-OF-SERVICE tag.

d) Remove four distance piece side cover mounting nuts off distance 4).

Delete. Substitute with steps from T/M S6220-EE-MMA-010 Change F para. 6-6.6.1.f through h (for the Rexnord coupling).

e) Disconnect drive coupling (8, Figure 6-4) through distance piece side cover (11, Figure 7-4), filter cover (12, Figure 7-4), and filter panel (13, Figure 7-4).

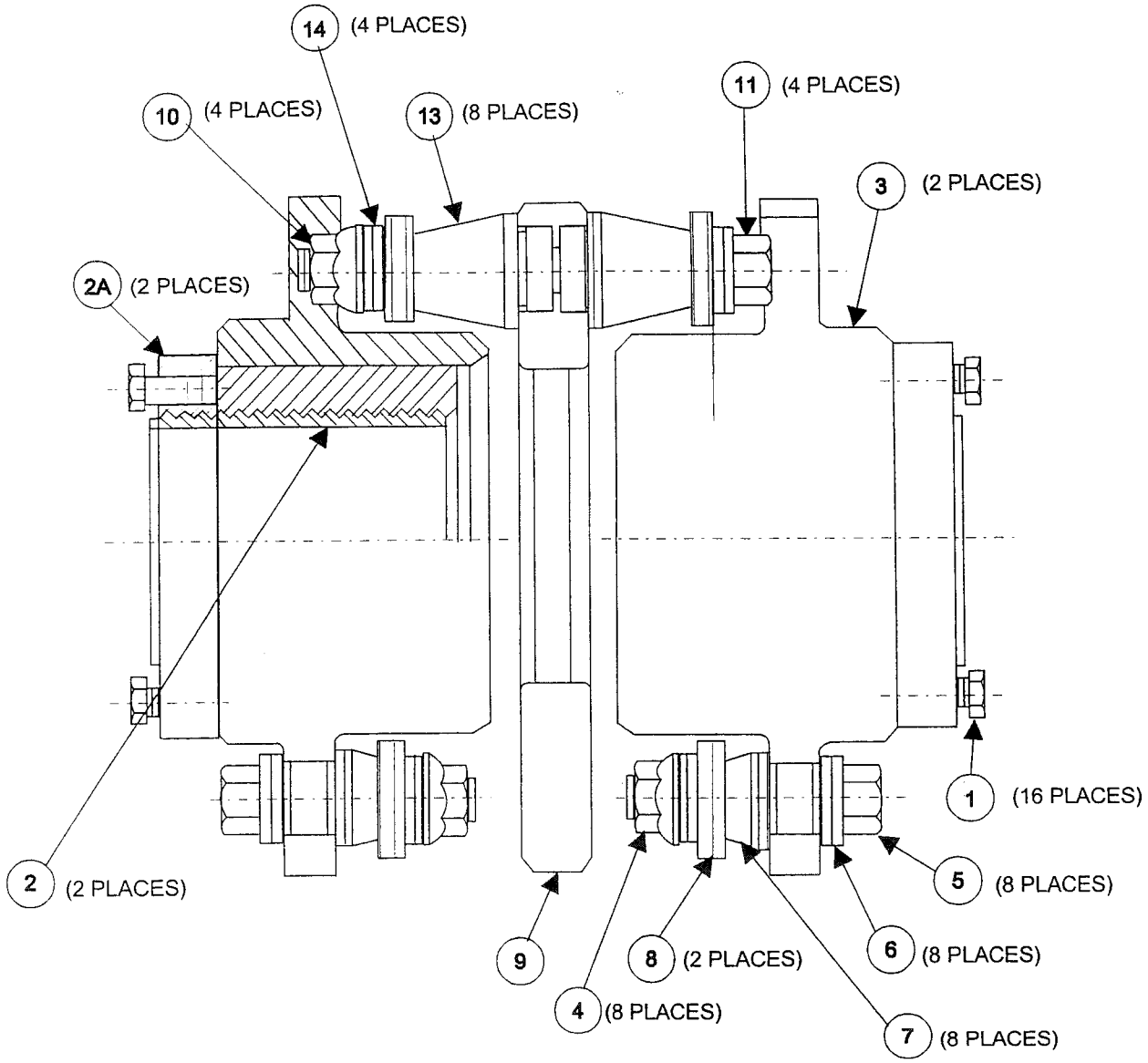
f) Force the wire ring on the sleeve out of its groove in the center of the sleeve. It may be necessary to pry the wire ring off with a blunt screwdriver.

g) Loosen the hex-head capscrews (1) and break bushing (2) loose on the end of coupling being disconnected.

h) The flange and part of the split sleeve can be removed during air-end or motor removal.

i) Remove either drive motor or compressor (IAW paragraphs 6-6.6.1 or 6-6.7.1).

j) Remove the flange, sleeve, and bushing (1) by sliding off the shaft.



LEGEND

1. HEX-HEAD CAPSCREW
2. BUSHING
2A. THREADED RING (PART OF BUSHING)
3. HUB
4. NUT
5. SHORT BOLT
6. LINKS
7. SHORT BEVEL WASHER
8. DISK PACK
9. CENTER RING
10. NUT
11. LONG BOLT (PART CENTER RING) (REF)
12. NOT USED
13. LONG BEVEL WASHER (PART CENTER RING) (REF)
14. LINK (PART OF CENTER RING)

Figure 6-8. Drive Coupling

NOTE

Match mark bolts on coupling before removing since they are balanced and

Delete. Substitute with steps from T/M S6220-EE-MMA-010
Change F para. 6-6.6.2.a through h (for the Rexnord coupling).
Re sequence subsequent steps.

of bushing (2).

l) If the bushing (2) will not break loose, the short bolts (5) will need to be removed. Proceed as follows:

1) Remove four nuts (4) from short bolts (5) securing hub (3) to disk pack (8) and pull bushing (2) and hub (3) away from center ring (9).

2) Remove four links (6).

NOTE

Match mark bolts on coupling before removing since they are balanced and must be installed in same location.

m) If the bushing (2) and the hub (3) can not be removed by removing the short bolts (5) the center ring must be disassembled as follows:

1) Remove four nuts (10) from four long bolts (11) securing center ring (9) to disk pack (8).

2) Remove four links (14).

NOTE

The hub (3) will be removed during air-end or drive motor removal.

n) If not already done, remove either drive motor or compressor assembly (IAW paragraphs 6-6.6.1 or 6-6.7.1).

o) Use a punch from shaft end to relieve taper on outer bushing sleeve and slide hub (3) from shaft.

6-6.5.2 Drive Coupling Replacement.

a) Inspect all coupling components and remove any protective coatings or lubricants from bores, mating surfaces, and fasteners. Remove any existing burrs from the shafts.

b) Slide coupling bushing and flange onto each shaft. It may be necessary to expand the bore of the bushing by wedging a screwdriver into the saw cut of the bushing.

c) Position the flanges on the shafts to approximate a "G" dimension of 3.5" (flanges approximately flush with the end of shafts). It is best to have an equal length of shaft extending into each flange. Tighten one flange by torquing the hex-head capscrews (1) to 9 ft. lbs.

d) Slide the other flange back far enough to install the sleeve. Do not move the sleeve center wire ring to its final position; allow it to hang loosely in the groove adjacent to the teeth until completing alignment steps (e) and (f). Reposition the flange and torque hex-head capscrews (1) to 9 ft. lbs.

e) Check parallel alignment by placing a straightedge across the two coupling flanges. Measure the maximum offset at various points around the periphery of the coupling without rotating the coupling. The maximum offset should not exceed .025".

f) Check angular alignment with a micrometer, vernier, or calipers. Measure dimension "G" from the outside of one flange to the outside of the other at intervals around the periphery of the coupling. Determine the maximum and minimum dimensions without rotating the coupling. These measurements must be between the range of 3.500" and 3.609". If a correction is necessary, recheck the parallel alignment.

g) Force the wire ring on the sleeve into its groove in the center of the sleeve. It may be necessary to pry the ring into position with a blunt screwdriver.

h) Turn drive coupling over by hand, ensuring all parts move freely.

i) Reinstall distance piece side cover (11, Figure 7-4), filter panel (13, Figure 7-4), and filter cover (12, Figure 7-4) using four distance piece side cover mounting nuts (7A, Figure 6-4).

j) If removed, reinstall compressor assembly components by reversing steps of paragraph 6-6.7.1.

k) Restore main power source to LPAC and remove OUT-OF-SERVICE tag.

6-6.6 Repairing/Replacing Drive Motor.

6-6.6.1 Removal/Replacement of Drive Motor. (Index numbers below refer to Figure 6-4 unless otherwise indicated.)

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when

power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

WARNING

To prevent injury or death, ensure equipment is de-energized and tagged OUT-OF-SERVICE at the source.

b) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.

c) Remove four drive motor connection box cover screws (1, Figure 6-10), lockwashers (2, Figure 6-9), cover (3, Figure 6-9) and gasket (4, Figure 6-9).

d) Tag and disconnect motor leads.

e) Loosen drive coupling (8) from drive motor shaft (IAW paragraph 6-6.5.1).

f) Shut-off seawater supply to LPAC. Then drain seawater and potable water from heat exchanger assembly (21).

g) Disconnect two seawater pressure-tubing lines at seawater gauge panel on end of drive motor (9).

h) Disconnect two temperature RTD leads to seawater heat exchanger piping.

i) Match mark flanges. Then remove seawater and potable water supply and drain hoses from heat exchanger assembly (21).

j) Remove heat exchanger mounting bolts and nuts. Then slide heat exchanger assembly (21) out of way so drive motor (9) can be pulled away from distance piece (16).

k) Remove air inlet filter (13) as follows:

1) Unscrew pressure drop indicator (12) by hand.

2) Loosen hose clamp holding suction unloader valve hose (4) to air inlet filter assembly (13) outlet pipe.

3) Disconnect seal vent line (1, Figure 6-4) located at bottom of filter outlet pipe.

4) If the ship's CBR filter is being used, disconnect the CBR filter flange at the air filter inlet flange.

5) Loosen filter hold-down straps (11), remove two bolts holding inlet of air inlet filter assembly (13) to bracket and slide air inlet filter assembly (13) out of filter hold down straps (11) and lift off. Remove filter bracket with seawater gauge panel from drive motor (9).

l) Loosen eight distance piece-to-motor mounting nuts (14).

m) Place compressor air end support fixture (FSCM 28953 P/N 33-AFIX100) or wooden support under compressor assembly distance piece end. Support fixture must allow for slight lowering of far end of compressor assembly (10).

CAUTION

To avoid damage, only an experienced hoist operator should be allowed to move heavy components.

n) Attach lifting hook to motor lifting eyes and take up slack.

o) Remove four drive motor mounting nuts (15) and eight distance piece-to-drive motor mounting nuts (14).

p) Loosen two distance piece-to-drive motor mounting nuts to allow motor removal and reassembly. Do not remove nuts.

q) Apply a strain to hoist, slide drive motor (9) back and lift away from distance piece (16).

r) Remove drive motor (9) from drive motor base (17).

s) Mark axial position of drive coupling (8) on drive motor shaft, then unbolt and remove drive coupling (8).

t) Reverse steps above to reinstall drive motor.

u) Restore main power source to LPAC and remove OUT-OF-SERVICE tag.

NOTE

Regrease bearings every six months of normal operation or one year of infrequent operation. If regreasing bearings, remove plugs (31, 32, 33, and 34, Figure 6-9).

v) Ensure that drain holes are clear by inserting a steel rod into motor openings. Remove rod.

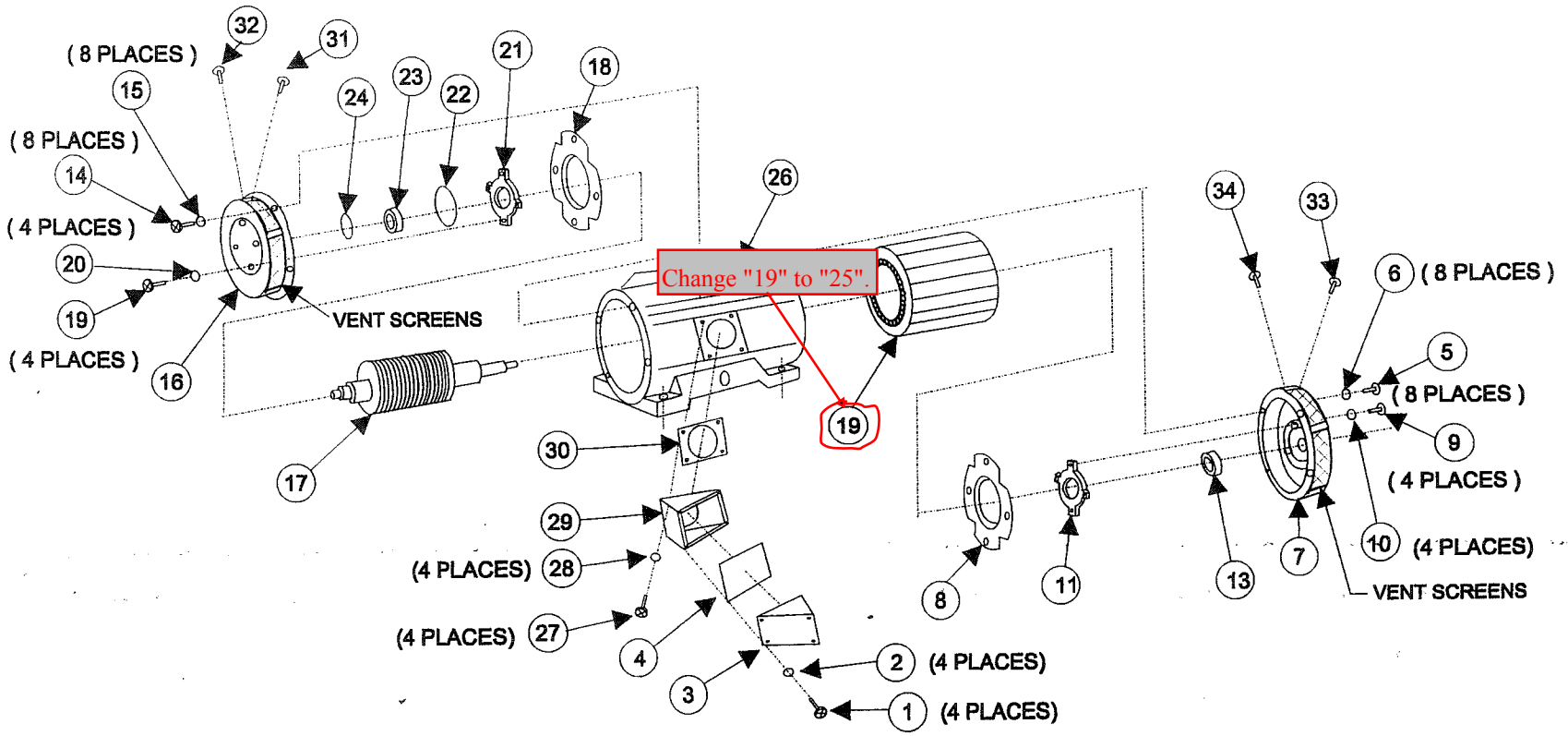


Figure 6-9. Drive Motor

S6220-EU-MMA-010

LEGEND

1. Screw
2. Lockwasher
3. Cover
4. Gasket
5. Screw
6. Lockwasher
7. End Shield
8. Baffle
9. Screw
10. Lockwasher
11. Bearing Cap
12. Not Used
13. Bearing
14. Screw
15. Lockwasher
16. End Shield
17. Rotor
18. Baffle
19. Screw
20 Lockwasher
21. Bearing Cap
22. Gasket
23. Bearing
24. Spring Washer
25. Stator
26. Frame
27. Screw
28. Lockwasher
29. Terminal Box
30. Gasket
32. Plug
33. Plug
34. Plug
35. Hex Nut
36. Spring Washer

Delete. Legend items 35 and 36 are not illustrated or listed in Paragraph 6-6.7.1.

CAUTION

Excessive lubrication may damage drive motor (9). Do not over grease.

w) Using a grease gun, pump two ounces of grease conforming to DOD-G-24508 into each inlet opening (31 and 33, Figure 6-9).

x) Replace inlet plugs (31 and 33, Figure 6-9), start LPAC and let run for one half hour to discharge excess grease.

y) Stop LPAC and replace two drain plugs (32 and 34, Figure 6-9).

z) Return LPAC to normal operations.

6-6.6.2 Disassembly/Reassembly of Drive Motor. (Index numbers below refer to figure 6-9 unless otherwise indicated.) Disassemble drive motor only to point necessary to repair or inspect. Reassemble from that point by reversing disassembly steps accomplished and reinstall drive motor (IAW paragraph 6-6.6.1).

a) Remove drive motor (IAW paragraph 6-6.6.1). Move to suitable work area.

b) Remove eight screws (5) and eight lockwashers (6) from end shield (7).

c) Gently tap end shield (7) off rotor (17) shaft.

d) Remove baffle (8).

e) Remove four screws (9) and four lockwashers (10).

f) Remove bearing cap (11).

g) Using a bearing puller, remove bearing (13) from rotor (17) shaft.

h) Remove eight screws (14) and eight lockwashers (15) from end shield (16).

CAUTION

To prevent damage, do not drag rotor iron across stator iron.

i) Remove end shield (16) with rotor (17).

j) Remove baffle (18).

k) Gently tap end shield (16) off rotor (17) shaft.

l) Remove four screws (19) and four lockwashers (20).

m) Remove bearing cap (21) and gasket (22).

n) Using a bearing puller, remove bearing (23) from rotor (17) shaft.

o) Remove stator (25) from frame (26).

p) Remove four screws (27) and four lockwashers (28).

q) Remove terminal box (29) and gasket (30).

r) If regreasing bearings, remove plugs (31, 32, 33, and 34) (IAW paragraph 6-6.6.1).

s) Inspect all parts for wear, breaks, discoloration due to overheat or missing/damaged insulation. Check ball bearings for freedom of rotation. Replace bearings that are noisy or hard to rotate.

CAUTION

When replacing ball bearing (13 and 23) on rotor (17) shaft, apply pressure only to inner race of bearing.

NOTE

Heat bearing (13 and 23) in an oven to a maximum of 250 degrees Fahrenheit. This will expand inner ring, permitting it to slide easily onto rotor (17) shaft. Do not heat bearing (13 and 23) beyond point necessary to expand inner ring desired amount.

t) Reverse steps above to reassemble drive motor.

u) Clean vent screens on both end shields (7 and 16).

v) Reinstall drive motor on LPAC (IAW paragraph 6-6.6.1).

6-6.7 Repair/Replacement of Compressor Air-end.

6-6.7.1 Removal/Replacement of Compressor Assembly. (Index numbers below refer to Figure 6-4 unless otherwise indicated.)

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

WARNING

To prevent injury or death, ensure equipment is de-energized and tagged OUT-OF-SERVICE at the source.

b) Turn OFF and lockout main LPAC power source. Install OUT-OF-SERVICE tag.

c) Open filter drain valve (13, Figure 2-2).

d) Remove suction unloader valve (6) (IAW paragraph 6-6.2.1).

e) Disconnect injection water line (18).

f) Disconnect air-end drain hose (14, Figure 6-6).

g) Disconnect and label lead from air-end RTD (15, Figure 6-6).

h) Disconnect and label lead from high temperature shut-down switch (12, Figure 6-6).

i) Remove air-end check valve assembly (1, Figure 6-6) (IAW paragraph 6-6.4.1).

j) Remove relief valve (IAW paragraph 6-6.1.1).

k) Disconnect seal vent line (1) from compressor (10).

Insert "casing".

CAUTION

To avoid damage, only an experienced hoist operator should be allowed to move heavy components to avoid their being damaged.

l) Attach lifting strap to underside of compressor assembly air-end so that it is fully supported.

m) Disconnect drive coupling (8) from compressor assembly (10) (IAW paragraph 6-6.5.1).

n) Remove eight compressor assembly mounting nuts (19) and work compressor assembly air-end off of distance piece studs. Carefully hoist compressor assembly (10) to a convenient work area.

o) Reinstall compressor assembly (10) by reversing the above steps.

p) Restore main source power to LPAC and remove OUT-OF-SERVICE tag.

6-6.7.2 Disassembly/Reassembly of Compressor Assembly. (Index numbers below refer to Figure 6-10 unless otherwise indicated.)

NOTE

It is recommended that repair/ maintenance work done on air-end be performed at a depot level. Special tooling and handling is required and unless shipboard personnel have specific training this work should not be attempted on the ship. If it is necessary, it may be possible to work on gate rotor assemblies which do not require special tooling, but there are still clearances that need to be set for the gate rotor assembly and between the gate rotor and the housing. Personnel must be trained to properly set-up gate rotor assembly.

These are the wrong figure references. Correct as required.

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

WARNING

To prevent injury or death, ensure equipment is de-energized and tagged OUT-OF-SERVICE at the source.

b) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.

c) Remove compressor assembly (10, Figure 6-4) (IAW paragraph 6-6.7.1).

d) Remove both gate rotors (IAW paragraph 6-6.4.1).

e) Remove eight nuts (1) on drive end.

f) Remove eight nuts (6) from drive-end bearing retainer (2).

g) Remove drive-end bearing retainer (2), seal (3), and o-ring (15).

h) Using a metal eyebolt with 1/2"-13UNC threads in the tapped hole at end of rotor shaft, pull main rotor (4) and drive-end bearing carrier (21) assembly free of suction-end bearing carrier (7) and out of

compressor assembly (5) housing. Use 3/8-16 jacking screws to remove suction-end bearing carrier (7), if necessary.

i) Remove eight nuts (1) on suction end.

j) Remove suction-end bearing carrier (7) and three o-rings (8 and 9) from studs (10). Use 3/8-16 jacking screws to remove suction-end bearing carrier (7), if necessary.

k) Disassemble main rotor (4) as follows:

1) Remove socket-head screw (11).
2) Remove suction-end bearing sleeve retainer (12) and suction-end bearing sleeve (13) from main rotor (4) shaft.
3) Using locknut tool (28953 P/N 33-B5844) and shaft tool (28953 P/N 88-B5659), remove locknut (14) from main rotor (4) shaft.
4) Remove v-ring seal (18), o-rings (24 and 30), seal cup (19), retaining ring (23), snap ring (22), labyrinth seals (25), retainers (33), and drive-end bearing carrier (21) from main rotor (4) shaft by lifting entire assembly up off of main rotor (4) shaft.
5) Remove three o-rings (8) from drive-end bearing carrier (21).

l) Inspect parts for broken or damaged components, excessive wear, and visual signs of overheating. Inspect carbon seals for damage. Inspect shims for bends and tears. During reassembly, replace all defective parts and install new o-rings and gaskets.

m) Reassemble main rotor assembly (IAW paragraph 6-6.7.3).

n) Install main rotor assembly into compressor housing as follows:

1) Ensure compressor assembly housing (5) is clean.
2) Set compressor assembly housing (5) on two wooden blocks with main rotor bore vertical and drive-end up. Use level to ensure housing (5) is level.
3) Place one .025" drive-end shim (29) on drive-end of compressor assembly housing (5).
4) Lower main rotor/drive-end bearing carrier (21) assembly into compressor housing (5). If main rotor (4) assembly fits tightly in compressor assembly housing (5), rotate it a few times to leave rub marks on rotor. Blueing can be used in labyrinth seal (25) area of main rotor (4) to detect high spots. Remove rotor/drive-end bearing carrier assembly from compressor assembly housing (5) and use emery cloth to dress down high spots. Reinstall rotor/drive-end bearing carrier assembly in compressor assembly housing (5) and recheck rotation. Repeat this operation until main rotor (4) is easily turned by hand without leaving marks on main rotor (4).

o) Refer to Figure 6-11 and adjust main rotor (4) concentricity as follows:

1) Set-up items as shown in Figure 6-11.
2) Measure run-out with dial indicator on machined shoulder of compressor assembly housing (5) flange. Total run-out should be .001" or less. If run-out is greater than .001", determine which direction the main rotor (4) should be moved. Mount main rotor location block on housing flange opposite the direction to be moved. A single block or two blocks 60 degrees apart can be used to move main rotor (4).
3) Using the locating block set screws, move main rotor (4) until the run-out is less than .001".
4) When run-out is acceptable, install two nuts (1) 180 degrees apart and finger tight.
5) Tighten installed nuts (1) to approximately 10 ft. lbs. and verify that main rotor (4) still turns easily. When verified, torque nuts (1) in increments of approximately 20 ft. lbs. to 76 ft. lbs.
6) Recheck total run-out.

p) Reassemble and install suction-end bearing carrier (7) as follows:

1) Insert snap ring (28) into suction-end bearing carrier (7).
2) Heat suction-end bearing carrier (7) in oven to 350 degrees Fahrenheit (approximately 30 minutes).
3) Slide carbon bushing (27) into suction-end bearing carrier (7) and insert second snap ring (28).
4) Coat three new o-rings (8 and 9) with silicon grease and install on suction-end bearing carrier (7).
5) Turn the housing 180 degrees (drive-end down).
6) Install suction-end bearing carrier (7), with o-rings (8 and 9) installed, on compressor assembly housing (5).
7) Install and tighten nuts (6) to 5 ft. lbs. tightening two at a time, 180 degrees apart. Ensure main rotor (4) turns freely after each pair of nuts are tightened. If not, tap suction-end bearing

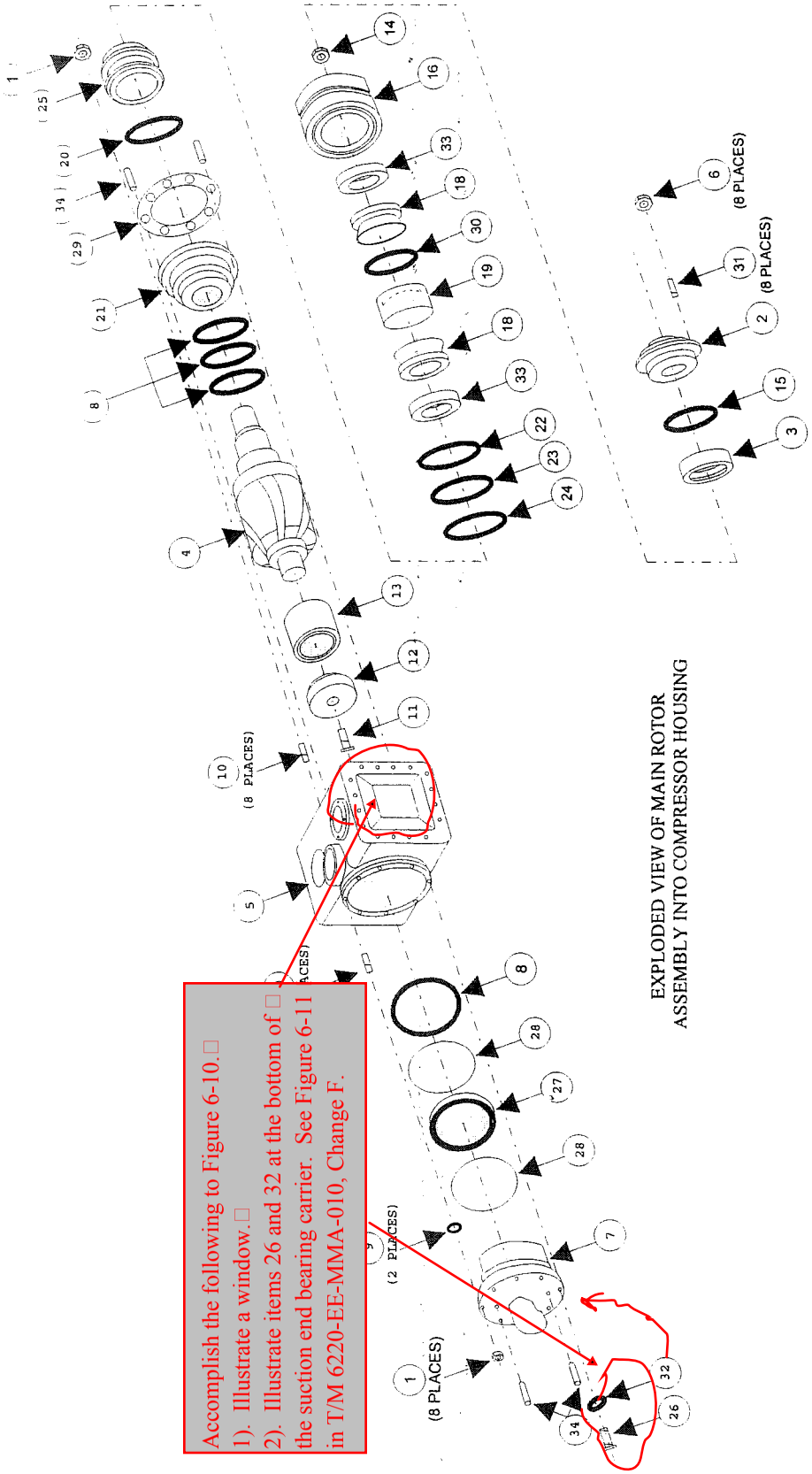


Figure 6-10. Main Rotor Assembly (sheet 1 of 2)

LEGEND

1. NUT
2. DRIVE-END BEARING RETAINER
3. SEAL
4. MAIN ROTOR
5. COMPRESSOR ASSEMBLY HOUSING
6. NUT
7. SUCTION-END BEARING CARRIER
8. O-RING (4 PLACES)
9. O-RING
10. STUD
11. SOCKET-HEAD SCREW
12. SUCTION-END BEARING SLEEVE RETAINER
13. SUCTION-END BEARING SLEEVE
14. LOCKNUT
15. O-RING
16. BALL BEARING
17. (NOT USED)
18. V-RING SEAL
19. SEAL CUP
20. O-RING
21. DRIVE-END BEARING CARRIER
22. SNAP RING
23. RETAINING RING
24. O-RING
25. LABYRINTH SEAL
26. PLUG
27. CARBON BUSHING
28. SNAP RING
29. DRIVE-END SHIM
30. O-RING
31. STUD
32. O-RING
33. RETAINER RING
34. DOWEL PIN

Figure 6-10. Main Rotor Assembly (sheet 2 of 2)

Figure 6-11. Identify "Dowels" as listed in paragraph 6-6.7.2.q.7.

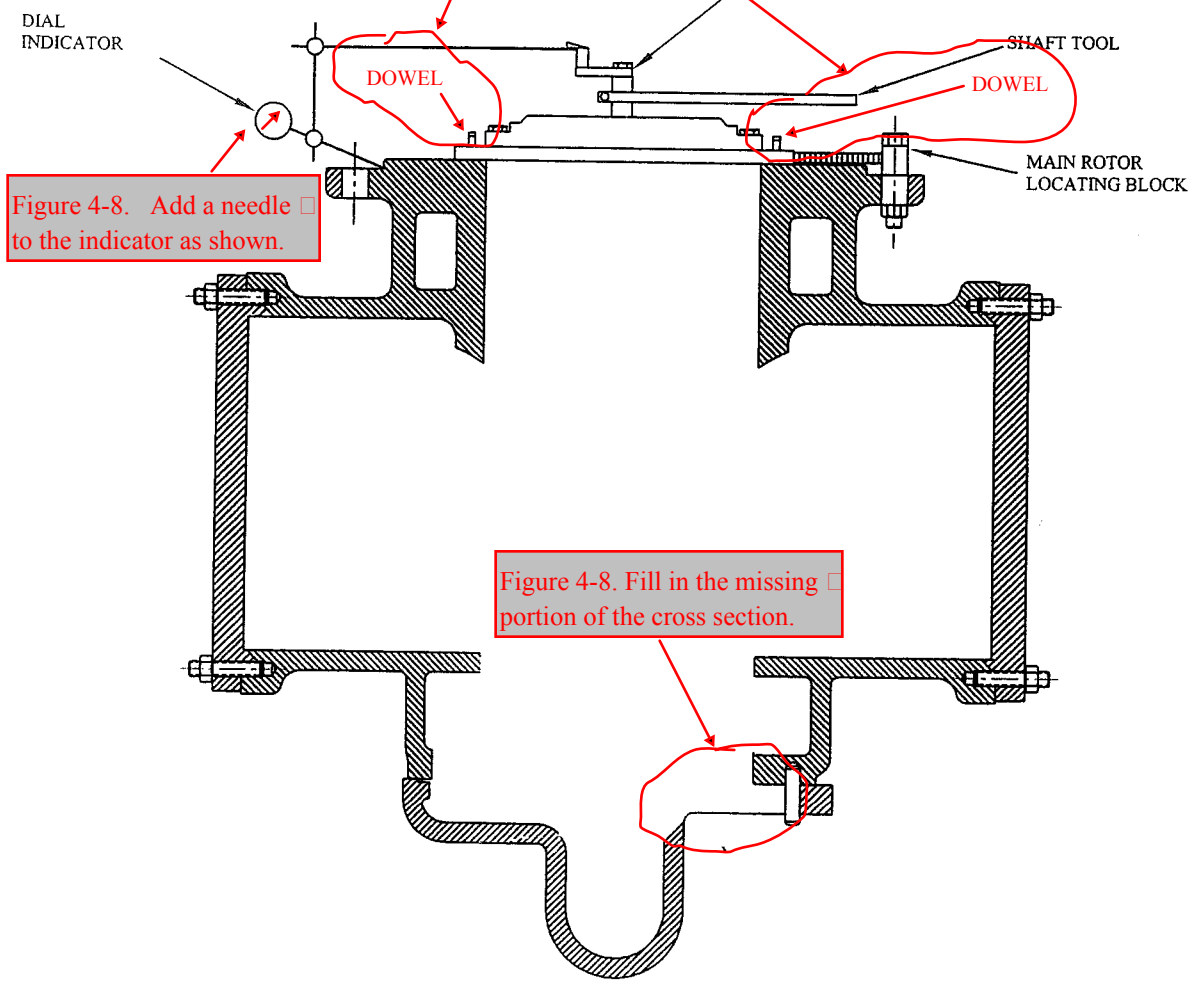


Figure 4-8. Add a needle to the indicator as shown.

Figure 4-8. Fill in the missing portion of the cross section.

TEST SETUP FOR ADJUSTING ROTOR

CONCENTRICITY WITH MAIN BORE

Figure 6-11. Rotor Concentricity Test Set-Up

carrier (7) in different directions until main rotor (4) turns freely. After all nuts (6) are installed, finish tightening to value listed in Table 6-1 in 20 ft. lb. Increments.

q) Center main rotor assembly as follows:

1) Remove gate rotors (IAW paragraph 6-6.4.1).

2) Install indicating fixture (P/N 33-AIND1003) in compressor assembly housing (5), in place of gate rotor assembly.

NOTE

Because of machining variations, not all grooves read the same; and the same groove reads differently from one gate rotor location to the other. However, no groove should read negative. In the worst case, the indicator should go from 0.0 to 0.0 when moving from suction-end to discharge end.

3) Measure the location of the bottom of groove in main rotor (4). It should indicate from 0.0" to +.001" when moving from suction-end to discharge end of groove. For + it is meant that bottom of groove moves closer to axis of fixture. Read all grooves. Repeat operation for all grooves at other gate rotor location.

4) If readings obtained in (3) above are out of tolerance, remove rotor/drive-end bearing carrier assembly (IAW steps e. and h. above). Change drive-end shims (29) to obtain proper reading. In general, for each .001" total readout change required on indicator, shims must be changed .001". For + readings add shims and for - readings remove shims.

5) Reinstall main rotor/drive-end bearing carrier assembly in compressor housing (5) (IAW steps n. and o. above and recheck IAW (3) above).

6) When main rotor is centered, tighten nuts (1) in increments of 1/4 of torque value listed in table 6-1.

7) Drill pilot holes for dowel pins to 23/64" diameter x 1.25 deep drive end (1.12 deep suction end) at point of drill. Ream holes to .375" diameter both ends. If using a new or different housing main rotor/drive-end bearing carrier assembly, or suction end bearing carrier (7), existing dowel pin holes will have to be drilled out for 7/16" diameter dowels. Drill out holes to 27/64" diameter x depth specified above. Ream to .4375" diameter.

8) Install dowel pins (34) on both ends.

9) Reinstall gate rotors (IAW paragraph 6-6.4.2).

6-6.7.3 Repair/Replacement of Main Rotor Drive-End Bearing Carrier. (Index numbers below refer to Figure 6-10 unless otherwise indicated.)

a) Remove compressor assembly housing (5) (IAW paragraph 6-6.7.1).

b) Remove gate rotor assemblies (IAW paragraph 6-6.4.1).

c) Remove main rotor (4) and disassemble (IAW paragraph 6-6.7.2 steps k and l above).

d) Set drive-end bearing carrier assembly (21), flange up, on three, two-inch-high wood blocks, and with at least one-inch clearance beneath it.

e) Replace labyrinth seal (25) as follows:

NOTE

De-burr edge in drive-end bearing carrier (21) with fine emery cloth to ease entry. Do not force labyrinth seal (25) into place. Place one hand under and one over the drive-end bearing carrier to guide labyrinth seal (25) straight downwards.

1) Install O-Ring (20) on labyrinth seal (25) and slide labyrinth seal (25) (tapered end downward) into drive-end bearing carrier (21).

2) Install o-ring (24) (lightly coated with silicone grease) on top of labyrinth seal (25), but do not press into its groove at this step. Smooth o-ring (24) to outer edge of labyrinth seal (25).

3) Install retaining ring (23) over o-ring and press it into place. Do not use excessive force, since damage to labyrinth seal (25) may result.

4) Install snap ring (22).

f) Replace main rotor/bearing carrier seals as follows:

1) Prepare a wooden block 10" X 10" X 4" thick with a 2.5" hole in center to accommodate suction end of main rotor (4) shaft.

2) Place main rotor (4) shaft into prepared block with drive-end upwards.

3) Place rotor spacer ring (28953 p/n 33-TOOL1) over drive-end of main rotor (4).

4) Slide drive-end bearing carrier assembly (21), with labyrinth seal (25), over main rotor (4) shaft until it seats on rotor spacer ring.

NOTE

Avoid chipping labyrinth seal (25) by striking against shaft.

5) Verify that main rotor (4) shaft shoulder, against which the ball bearings fit, is 1/16" to 3/32" higher than the corresponding shoulder in drive-end bearing carrier (21). This can be done with a depth micrometer, vernier caliper, or a straight edge and ruler using the drive-end bearing carrier (21) surface as a reference. If not, shim or reduce the thickness of the split ring.

NOTE

Step (5) above is important to ensure that ball bearings (16) sit properly against the shaft shoulder when pressed into place and to properl[illegible] seal (18) on shaft.

Don't forget the global comment to change the reverse quote marks to the inch symbols.

6) Slide a V-ring seal (18) with flexible lip up over tapered end of installation sleeve (1, Figure 7-13) until the V-ring seal (18) starts to stretch on the sleeve.

7) Install a retainer ring (33) over the V-ring seal (18) flange and push the V-ring/retainer assembly over the sleeve until it is completely past the tapered sections of the sleeve.

8) Slide the sleeve with the tapered end up onto the main rotor (4) shaft.

9) Thread a stud 1/2-13UNC x 6" long into the end of the main rotor (4) shaft.

10) Slide the insertion tool (2, Figure 7-13) large bore 1st onto the shaft and place the installation plug (3, Figure 7-13) over the stud with the 1-7/8" diameter up.

11) Install a 1/2" washer and 1/2-13UNC nut on the stud and tighten the nut until the shaft bottoms out against the installation plug. This positions the V-ring seal (18) correctly.

12) Install o-ring (30) on seal cup (19) and carefully press it into drive-end bearing carrier (21) with flat face down until it seats against shoulder provided for it.

13) Slide the second V-ring seal (18) with flexible lip down over tapered end of installation sleeve (1, Figure 7-13) until the V-ring seal (18) starts to stretch on the sleeve.

14) Install a retainer ring (33) over the V-ring seal (18) flange and push the V-ring/retainer assembly over the sleeve until it is completely past the tapered section of the sleeve.

15) Slide the sleeve with the tapered end up onto the main rotor (4) shaft.

16) Thread a stud 1/2-13UNC x 6" long into the end of the shaft.

17) Slide the insertion tool (2, Figure 7-13) large bore first onto the shaft and place the installation plug (3, Figure 7-13) over the stud with the 1-7/8" diameter down inside the bore of the insertion tool.

18) Install a 1/2" washer and 1/2-13UNC nut on the stud and tighten the nut until the shaft bottoms out against the installation plug. This puts the 2nd V-ring seal (18) in the correct position.

g) Replace ball bearing (16) as follows:

1) If not received with grease, fill a matched pair of bearings (16) about 1/3 full of DOD-G-[illegible]8 grease. This is accomplished by filling [illegible] of circumference on both sides and spreading it evenly by turning bearing inner race, pressing grease between balls.

WARNING

To avoid serious injury, wear insulated gloves when handling extremely cold or hot components.

2) If a press is used to install bearing (16), inner-bearing race will not have to be heated. If a press is not available, first warm drive-end bearing carrier (21) to 160 to 180 degrees Fahrenheit, using a hot air gun or gas torch. After heating, bearings (16) can be tapped into place.

NOTE

Ensure that orientation is correct (the thin edge of both outer races facing each other).

3) Press bearings (16) into place one at a time. use a flat metallic ring 1" thick, 5" O.D. and 2.5" I.D. (28953 P/N 33-TOOL2) provided with tapped holes for removal and a 4 1/2" long piece of 3.5 pipe or tool 28953 P/N 33-TOOL4.

4) Using locknut tool (28953 P/N 33-B5844) and torque tool (28953 P/N A33-B5743), install lock nut (14) and torque to 250 ft. lbs.

5) Drive-end bearing retainer (2) installation:

(a) Remove spring from lip seal and install lip seal (3) with lip facing down and o-ring (15)

in drive-end bearing retainer (2). Fill space around lip with DOD-G-24508 grease. Spread grease over inside surface of drive-end bearing retainer (2), except for 2" long area around the vent hole, and install it over ball bearings (16). Notch in drive-end bearing retainer (2) is oriented toward weep hole in drive-end bearing carrier (21).

6) Install nuts (6) and torque to 15 ft lbs.
7) Remove split ring (FSCM 28953 p/n 33-TOOL1).
8) Install three o-rings (8) on drive-end bearing carrier (21).

NOTE

Suction-end bearing sleeve (13) may have to be heated to get it on rotor shaft.

9) Install suction-end bearing sleeve (13) and suction-end bearing sleeve retainer (12) on main rotor (4) shaft. Install socket-head screw (11) and torque to value shown in table 6-1.

h) Reinstall drive-end bearing carrier (21), main rotor (4), gate rotors, and compressor assemblies (IAW steps 6-6.7.2 n., o., and q.; and reversing step a. above).

6-6.7.4 Flushing Potable Water Loop. The following procedure is for flushing the potable water system after an air-end has been changed out or repaired in place and the failure has put debris such as carbon from a carbon bushing failure into the system. If there is no contamination of the potable water loop (i.e., ball bearing (16) failure) flushing is not required.

NOTE

All o-rings, gaskets, and any other pipe connection sealing items should be replaced during reassembly.

a) Before air end is reinstalled, remove air end discharge hose at the separator flange (2, Figure 7-6).
b) Drain all potable water from the system using the filter drain and separator drain valves (13 and 15, Figure 2-2).
c) Remove check valve (7, Figure 7-6) and drain plug (18, Figure 6-20) from bottom of separator.
d) Flush separator by putting water into the open flange and letting the water drain out the bottom. Use a source of clean fresh water under at least 40 psi pressure and a flow rate of 20 gpm.
e) Disconnect hose from check valve (7, Figure 7-6) that was removed from the separator.
f) Disconnect potable water inlet and outlet hose flanges (35 and 36, Figure 7-6) from heat exchanger (Figure 1-2).
g) Flush potable water side of heat exchanger (Figure 1-2) by putting water into the top nozzle and letting the water drain out the bottom nozzle.
h) Disconnect inlet and outlet hose fittings (5, Figure 7-6) on water filter and inlet and outlet hose fittings (5, Figure 7-6) on the injection solenoid valve.
i) Remove water filter top cover (2, Figure 6-16). Remove filter element (6, Figure 6-16) and flush or replace the element. Flush the inside of the water filter body. Wipe down by hand using lint-free rags.
j) Disconnect hoses from inlet and outlet to suction drain valve (18, Figure 7-7).
k) Open the shut-off/injection solenoid valve (figure 1-2) manual actuator wheel and flush out solenoid valve. When flushing is complete shut valve by rotating actuator wheel in opposite direction.
l) Flush check valve from separator, suction drain valve, and all disconnected hoses.
m) Disconnect hoses from unloader solenoid valve (7, Figure 7-7). Flush solenoid valve and hoses. Check exhaust silencer (10, Figure 7-7) to ensure it is not clogged. Clean as necessary.
n) Flush out air-end components before reinstalling air end. With gate rotor covers removed, wipe down all accessible surfaces with a lint free rag.
o) Reassemble all hoses and components that were removed or disconnected. Replace water filter cover gasket (3, Figure 6-16), discharge check valve gaskets (5 and 11, Figure 6-6), heat exchanger potable water flange gaskets (15, Figure 7-6), separator check valve o-ring (34, Figure 7-6), and separator flange gasket (33, Figure 7-6).
p) Remove plug (12, Figure 6-16) on top of water filter.
q) Open cooler and filter fill valve (14, Figure 2-2). Close valve when water reaches filter vent plug and replace plug.
r) Open cooler and filter fill (14, Figure 2-2) valve again.
s) With a plastic window in place on the air end, open the shut-off/injection solenoid valve (Figure 1-2) manual actuator wheel until water reaches the top of the window and then close the shut-off/injection

solenoid valve (Figure 1-2) by rotating actuator in opposite direction.

t) Close the cooler and filter fill valve and open separator fill valve (14 and 12, Figure 2-2). When water reaches normal level in separator, close separator fill valve (12, Figure 2-2). Restore main power to LPAC.

u) When the air system is pressurized, leak test the joints and fittings using a soapy solution in a squirt bottle. Observe for formation of bubbles. Tighten or replace the sealing item in any joint or fitting found to be leaking.

v) Inspect the water plumbing for leaks and correct as required.

6-6.8 Cleaning Unloader Piping Orifices. (Refer to Figure 1-2.)

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

WARNING

To avoid harm to personnel, LPAC must not be started with hose lines loose or disconnected.

b) Turn OFF and lockout main source power to LPAC. Install OUT-OF-SERVICE tag.

c) Clean three unloader piping orifices as follows:

1) From one branch of tee fitting on end of unloader (blowdown) valve (figure 1-2) follow line that drops down behind PLC console. Next to muffler (a cast aluminum canister) is a brass fitting containing an orifice. Unscrew fitting to get at passage that should be cleaned with a bristle brush.

2) From other branch of tee fitting on rear of unloader (blowdown) valve (figure 1-2) follow line that enters a tee fitting on suction unloader valve (6, Figure 6-4). Branch that enters diaphragm cover (3, Figure 6-5) contains a second orifice through which air passes to activate diaphragm (4, Figure 6-5). The third unloader piping orifice is contained in fitting between tee and connection entering side of suction unloader valve housing (18, Figure 6-5). Disconnect hose lines at tee, unscrew both fittings containing second and third orifice and clean them with a bristle brush.

d) Reverse steps above to reconnect unloader piping orifice lines.

e) Restore main power source to LPAC and remove OUT-OF-SERVICE tag.

6-6.9 Maintaining Potable Water Check Valve. (Index numbers below refer to Figure 6-12 unless otherwise indicated.)

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

WARNING

To avoid harm to personnel, LPAC must not be started with check valve loose or removed.

b) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.

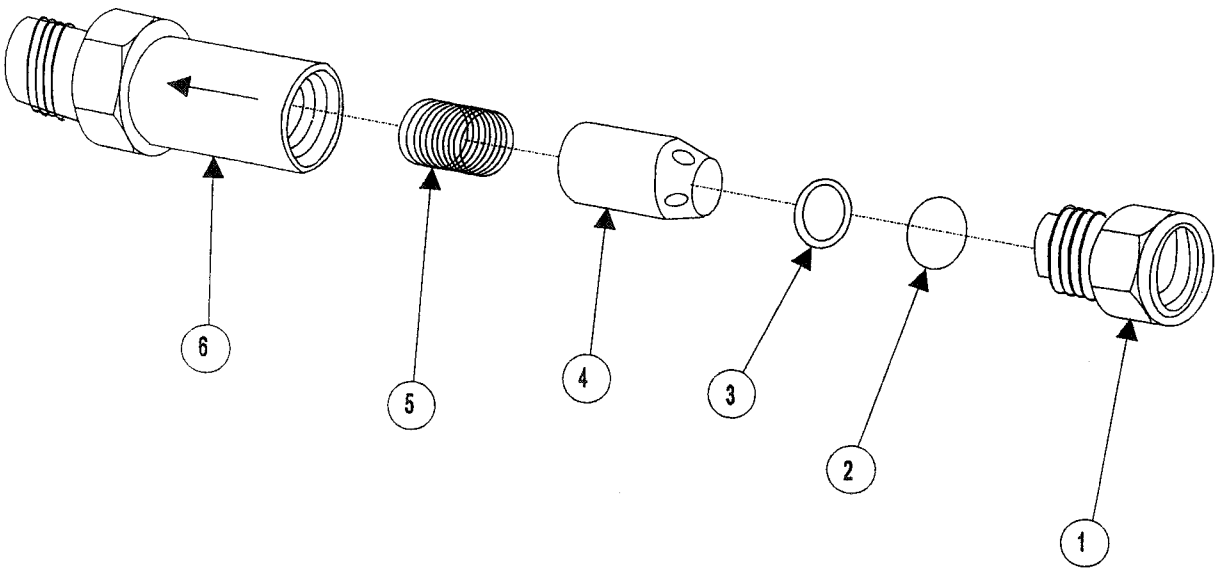
c) Close ship's potable water supply valve to LPAC.

NOTE

Be prepared for discharge of residual water when hose is disconnected.

d) Disconnect water hose from check valve (21, Figure 7-7).

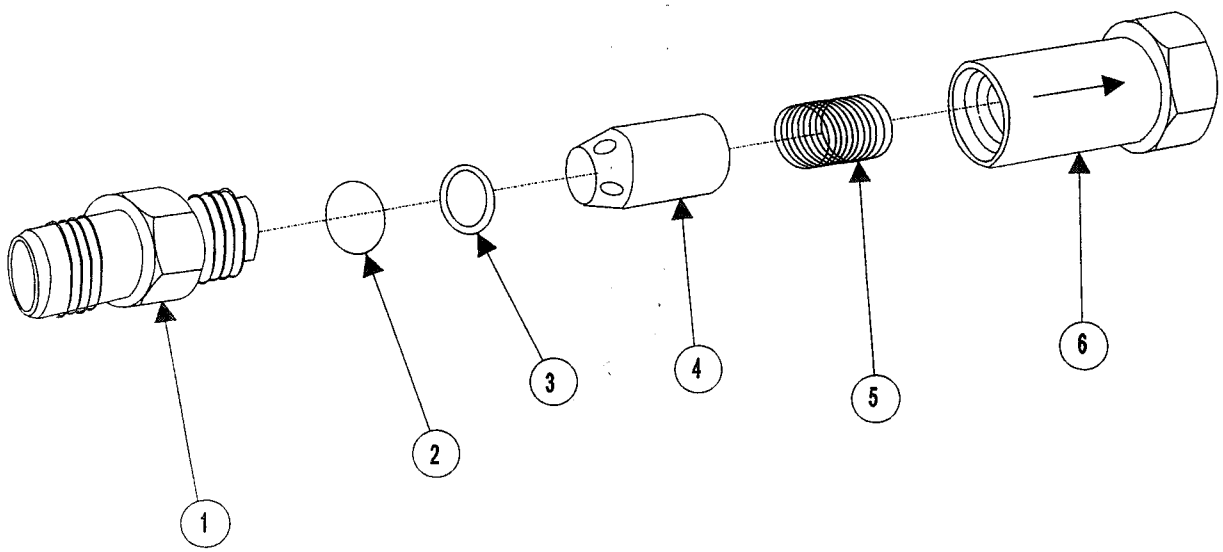
e) Refer to Figure 7-7 and remove check valve (21) and pipe nipple (48) from drain manifold block (22).



LEGEND

1. CAP
2. SEAL
3. RETAINER
4. POPPET
5. SPRING
6. BODY

Figure 6-12. Potable Water Check Valve



LEGEND

1. CAP
2. SEAL
3. RETAINER
4. POPPET
5. SPRING
6. BODY

Figure 6-13. Injection Water Loop Check Valve

f) Unscrew check valve cap (1) from body (6).

g) Remove seal (2), retainer (3), poppet (4), and spring (5).

h) Clean filter (62, Figure 7-7), adapter and check valve (21, Figure 7-7) parts in a detergent solution.

i) Inspect all components for gouges, burrs, and corrosion.

NOTE

Install check valve (21, Figure 7-7) with arrow on body (6) pointing in direction of flow (away from distribution block).

j) Reverse steps above to reassemble check valve (21, Figure 7-7), reinstall components, and restore LPAC operation.

6-6.10 Maintaining Injection Water Loop Check Valve.
(Index numbers below refer to Figure 6-13 unless otherwise indicated.)

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration

WARNING

To avoid harm to personnel, LPAC must not be started with check valve loose or removed.

a) Set MAN/AUTO selector switch (4, Figure 2-1) to MAN.

b) Turn OFF and lockout main power source for LPAC. Install OUT-OF-SERVICE tag. Close ship's potable water supply valve to LPAC.

c) Open separator drain valve (15, Figure 2-2). Drain until separator empty, then close valve.

d) Remove water filter vent plug (12, Figure 6-16) from top of water filter assembly.

e) Open filter drain valve (13, Figure 2-2). Drain until water filter assembly is empty, then close valve.

NOTE

Be prepared for discharge of residual water when hose is disconnected.

f) Disconnect injection water loop hose from check valve (7, Figure 7-6).

g) Remove check valve (7, Figure 7-6), and o-ring (34, Figure 7-6).

NOTE

Repair of check valve (7, Figure 7-6) is limited to cleaning or replacement of suspected bad components. If available, replace seal (2), spring (5), and o-ring (34, Figure 7-6) any time check valve (7, Figure 7-6) is disassembled.

h) Unscrew cap (1) from check valve body (6).

i) Remove seal (2), retainer (3), poppet (4), and spring (5).

j) Clean parts in a detergent solution. If necessary, brush away any fouling with a stiff bristle brush. Inspect components for gouges, burrs, or corrosion. Replace suspected bad components.

k) Reverse steps above to reassemble check valve.

NOTE

Install check valve with arrow on body (6) pointing in direction of flow away from separator.

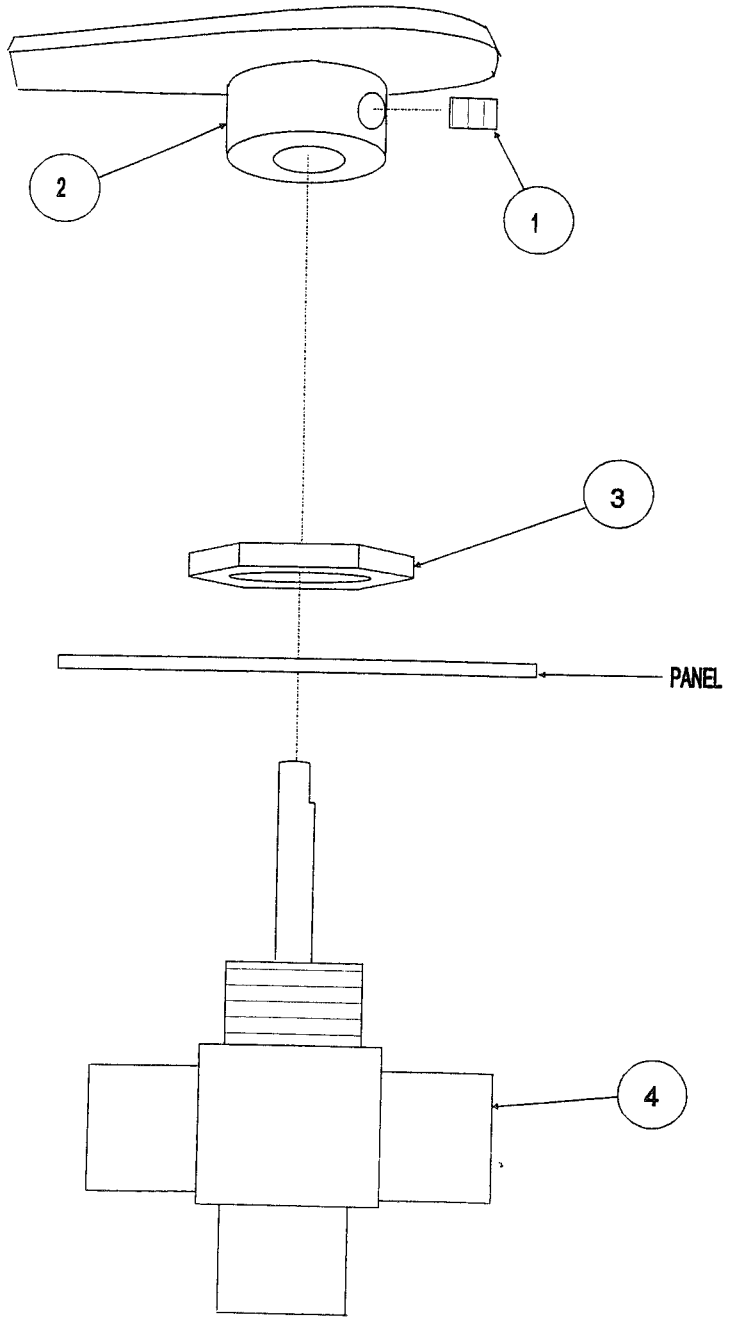
l) Reinstall check valve and re-attach water line.

m) Open cooler and filter fill valve (14, Figure 2-2). When water filter assembly is full, close valve.

n) Reinstall filter vent plug (12, Figure 6-16) and open cooler and filter fill valve (14, Figure 2-2).

o) Open shut-off/injection solenoid valve (figure 1-2) actuator for 30 seconds; then close.

p) Close cooler and filter fill valve (14, Figure 2-2).



LEGEND

1. SET SCREW
2. VALVE HANDLE
3. NUT
4. BODY

Figure 6-14. Seawater Inlet/Outlet Pressure Gauge Selector Valve

q) Open separator fill valve (12, Figure 2-2) until separator assembly water level reaches normal level, then close valve.

r) Open ship's potable water supply valve to LPAC. Return LPAC to service.

6-6.11 Maintaining Cooling Seawater Inlet/Outlet Pressure Gauge Selector Valve. (Index numbers below refer to Figure 6-14 unless otherwise indicated.)

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

WARNING

To avoid harm to personnel, LPAC must not be started with valve loose or removed.

b) Turn OFF and lockout main power source for LPAC. Install OUT-OF-SERVICE tag.

c) Close ship's seawater supply valve to LPAC heat exchanger.

d) Open heat exchanger seawater drain valve (figure 1-2) and drain seawater side of heat exchanger. Close valve when heat exchanger has drained.

NOTE

Be prepared for discharge of residual water when tubing is disconnected.

e) Disconnect tubing to back of cooler seawater pressure gauge selector valve (20, Figure 2-2).

f) Loosen setscrew (1) and remove valve handle (2).

g) Remove nut (3) then remove valve out backside of panel. If damage found, replace entire valve assembly.

h) Reverse steps above to reassemble and reinstall valve.

i) Open ship's seawater supply valve for LPAC heat exchanger and fill heat exchanger.

j) Restore LPAC main power source and remove OUT-OF-SERVICE tag.

6-6.12 Replacing Pressure Gauges.

6-6.12.1 Replacing Cooling Seawater Inlet/Outlet Pressure Gauge.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to MAN.

b) Turn OFF and lockout main LPAC power source. Install OUT-OF-SERVICE tag.

c) Close cooling seawater inlet/outlet pressure gauge valve (19, Figure 2-2).

d) Disconnect tubing lines at back of pressure gauge (18, Figure 2-2).

e) Remove three screws and pressure gauge (18, Figure 2-2) from bracket.

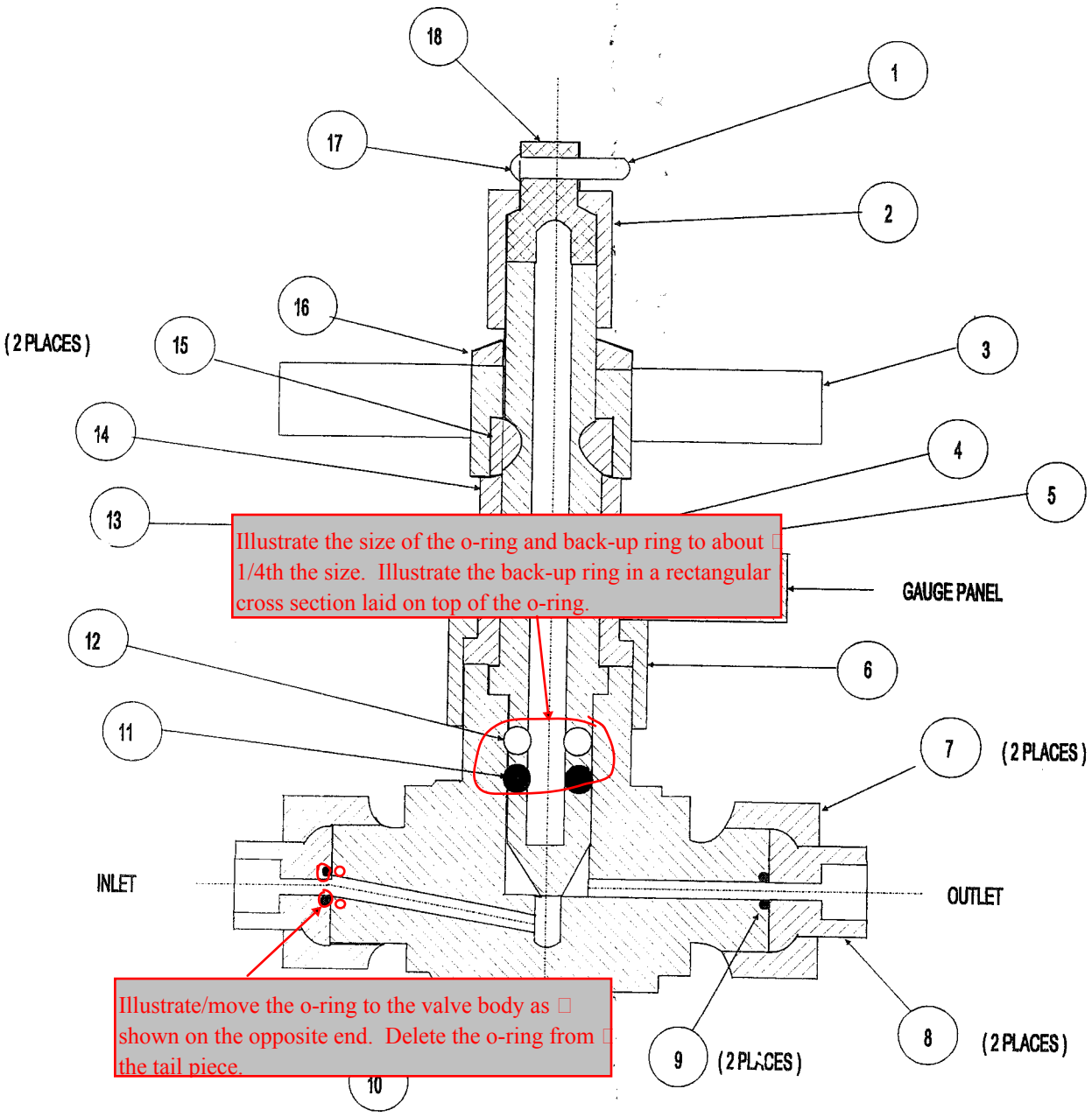
f) Reverse steps above to install replacement pressure gauge.

g) Restore main power source to LPAC and remove OUT-OF-SERVICE tag.

6-6.12.2 Replacing Gauge Panel Pressure Gauges. To remove any of three pressure gauges mounted on gauge panel (4, Figure 2-2) requires essentially same steps (except for identification wording). To replace pressure gauge (6, 8, or 10, Figure 2-2) proceed as follows:

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.



LEGEND

1. LANYARD
2. CAP NUT
3. HANDLE
4. PANEL LOCKNUT
5. LOCKWASHER
6. BONNET NUT
7. UNION NUT
8. UNION TAILPIECE
9. O-RING
10. BODY
11. O-RING
12. BACK-UP RING
13. STEM
14. BONNET
15. SPLINE KEY
16. HANDLE LOCKNUT
17. CAP
18. STOP SLEEVE

Figure 6-15. Gauge Valve

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

b) Turn OFF and lockout main power source for LPAC. Install OUT-OF-SERVICE tag.

c) Close appropriate pressure gauge valve (6, 8, or 10, Figure 2-2).

d) Disconnect tubing at back of the appropriate pressure gauge.

e) Remove three screws from back of appropriate gauge and lift gauge out of its location from front of gauge panel (4, Figure 2-2).

f) Reverse steps above to install replacement pressure gauge.

g) Restore main power source to LPAC and remove OUT-OF-SERVICE tag.

6-6.13 Maintaining Pressure Gauge Valves. (Index numbers below refer to Figure 6-15 unless otherwise indicated.) Maintenance of all pressure gauge valves (5, 7, 9, and 19, Figure 2-2; 3, Figure 7-14) is the same. The gauge valves in Figure 7-14 are not mounted on a gauge panel.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

WARNING

To avoid harm to personnel, LPAC must not be started with valve disconnected or removed.

b) Turn OFF and lockout main power source for LPAC. Install OUT-OF-SERVICE tag.

c) Remove the following on the faulty gauge valve: cap nut (2), handle locknut (16), handle (3), spline key (15), panel locknut (4), and lockwasher (5).

d) At the back of valve, disconnect inlet and outlet tubing and remove valve.

NOTE

Repair of valve is limited to cleaning or replacement of suspected bad components. Install new o-rings during reassembly.

e) Remove bonnet nut (6) and lift bonnet (14) off stem (13).

6-6.14 Replacing Water Filter Elements.

6-6.14.1 Replacing Closed Loop Water Filter Element.
(Index numbers below refer to Figure 6-16 unless otherwise indicated.)

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

WARNING

To avoid harm to personnel, LPAC must not be started with valve disconnected or removed.

b) Turn OFF and lockout main source power for LPAC. Install OUT-OF-SERVICE tag.

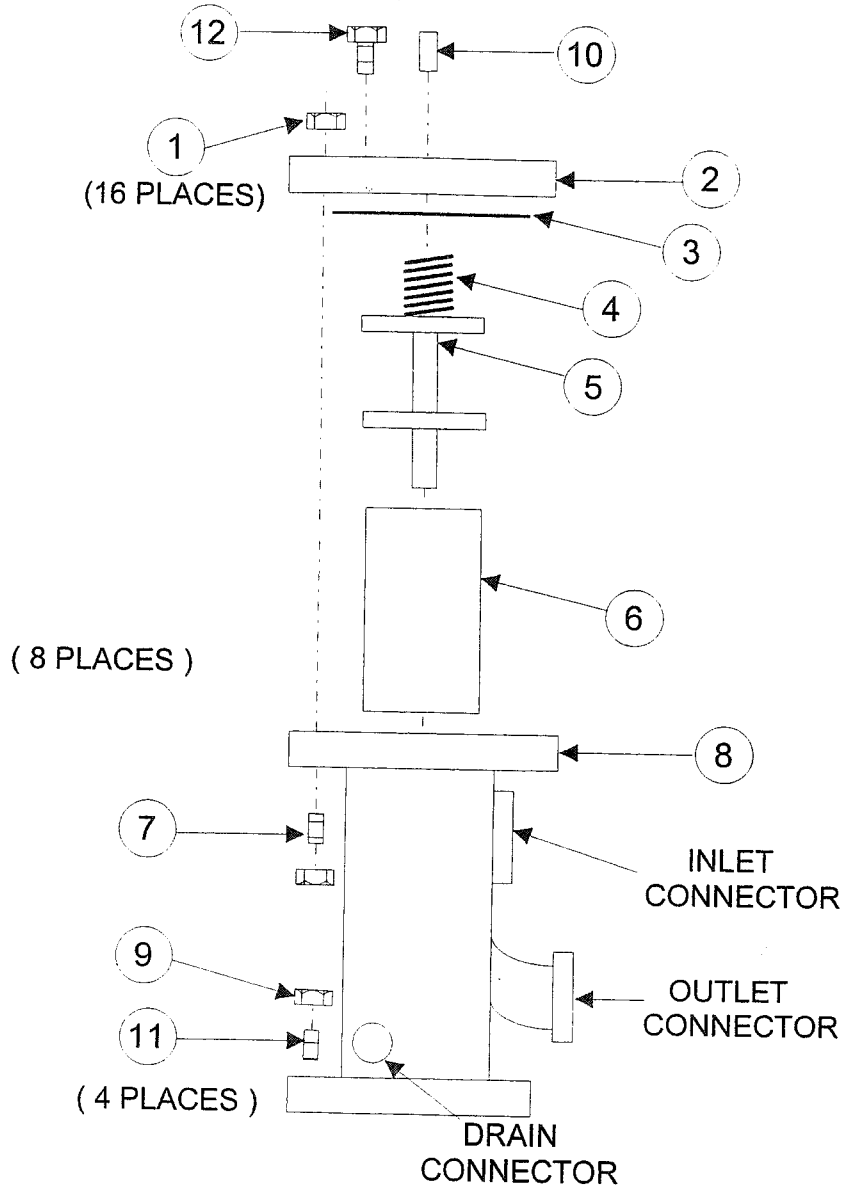
WARNING

Open the drain/pressure relief valve prior to opening the water filter assembly. This is necessary in order to relieve pressure in the filter housing to eliminate the possibility of personnel injury.

c) Open filter drain valve (13, Figure 2-2) and separator drain valve (15, Figure 2-2).

d) Remove filter vent plug (12) and drain separator water below the sight glass (16, Figure 2-2).

e) Close filter drain valve (13, Figure 2-2) and separator drain valve (15, Figure 2-2).



LEGEND

1. NUT
2. WATER FILTER TOP COVER
3. WATER FILTER COVER GASKET
4. SPRING
5. FILTER GUIDE
6. FILTER ELEMENT
7. STUD
8. FILTER HOUSING
9. NUT
10. INJECTION WATER TEMPERATURE RTD (REFERENCE)
11. STUD
12. PLUG

Figure 6-16. Water Filter Assembly

f) Disconnect lead J3-4 to injection water temperature RTD (10).

g) Remove eight nuts (1). Note that two brace mounting studs are longer than rest of studs.

h) Mark water filter top cover (2) for proper replacement.

i) Lift off water filter top cover (2) and gasket (3).

j) Lift filter guide (5) and spring (4) out of filter housing (8).

k) Lift water filter element (6) straight out of filter housing (8).

l) Reverse steps (f) through (k) above to install replacement element. Use new gasket. Torque nuts (1) to 24 ft. lbs. in a cross pattern.

m) Open cooler and filter fill valve (14, Figure 2-2) to vent water filter assembly. When water filter assembly is full, close valve.

n) Install filter vent plug (12). Open cooler and filter fill valve (14, Figure 2-2).

o) Open shut-off/injection solenoid valve (figure 1-2) actuator, for 30 seconds; then close.

p) Close cooler and filter fill valve (14, Figure 2-2).

q) Open separator fill valve (12, Figure 2-2) until water level reaches normal level on controller display and then close valve.

r) Restore main source power to LPAC and remove the OUT-OF-SERVICE tag.

6-6.14.2 Replacing Inlet Water Filter Element. (Index numbers below refer to Figure 7-7 unless otherwise noted.)

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

b) Turn OFF and lockout main source power for LPAC. Install OUT-OF-SERVICE tag.

c) Turn off ship's potable water supply to compressor.

d) Remove top cover of filter body (61) with hoses and fittings attached.

e) Remove filter element (62) and install new element.

f) Reinstall top cover and tighten hex-head bolt. Filter inlet should be on top and filter outlet on the bottom.

g) Turn on ship's potable water supply to compressor.

h) Restore main power to LPAC.

6-6.15 Repair and Maintenance of Solenoid Valves. Assuming proper control voltages, solenoid valves may fail to operate due to an open solenoid coil or binding caused by damaged or dirty internal parts. Dirty, damaged, or worn internal parts may also result in the valve failing to close completely. Solenoid valve maintenance actions include:

a) Testing. To test valve, follow procedures in paragraph 5-4.4 to check solenoid operation. A metallic "click" signifies that solenoid is operating properly. If metallic "click" is not heard check for an open coil.

b) Cleaning. Solenoid valves should be cleaned periodically. The time between cleanings varies depending on service conditions. If voltage to coil is correct then sluggish valve operation, excessive noise, or leakage indicate cleaning is required.

c) Disassembly/Reassembly. It is not necessary to remove valve to clean or repair it. The paragraphs below describe disassembly of each type solenoid valve. Disassemble valve only to point necessary to complete maintenance action. Reverse disassembly steps to reassemble valve.

6-6.15.1 Make-Up and Drain Solenoid Valve. (Index numbers below refer to Figure 6-17 unless otherwise indicated). If testing indicates that make-up and drain solenoid valves require repair or cleaning, disassemble the valve as follows:

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

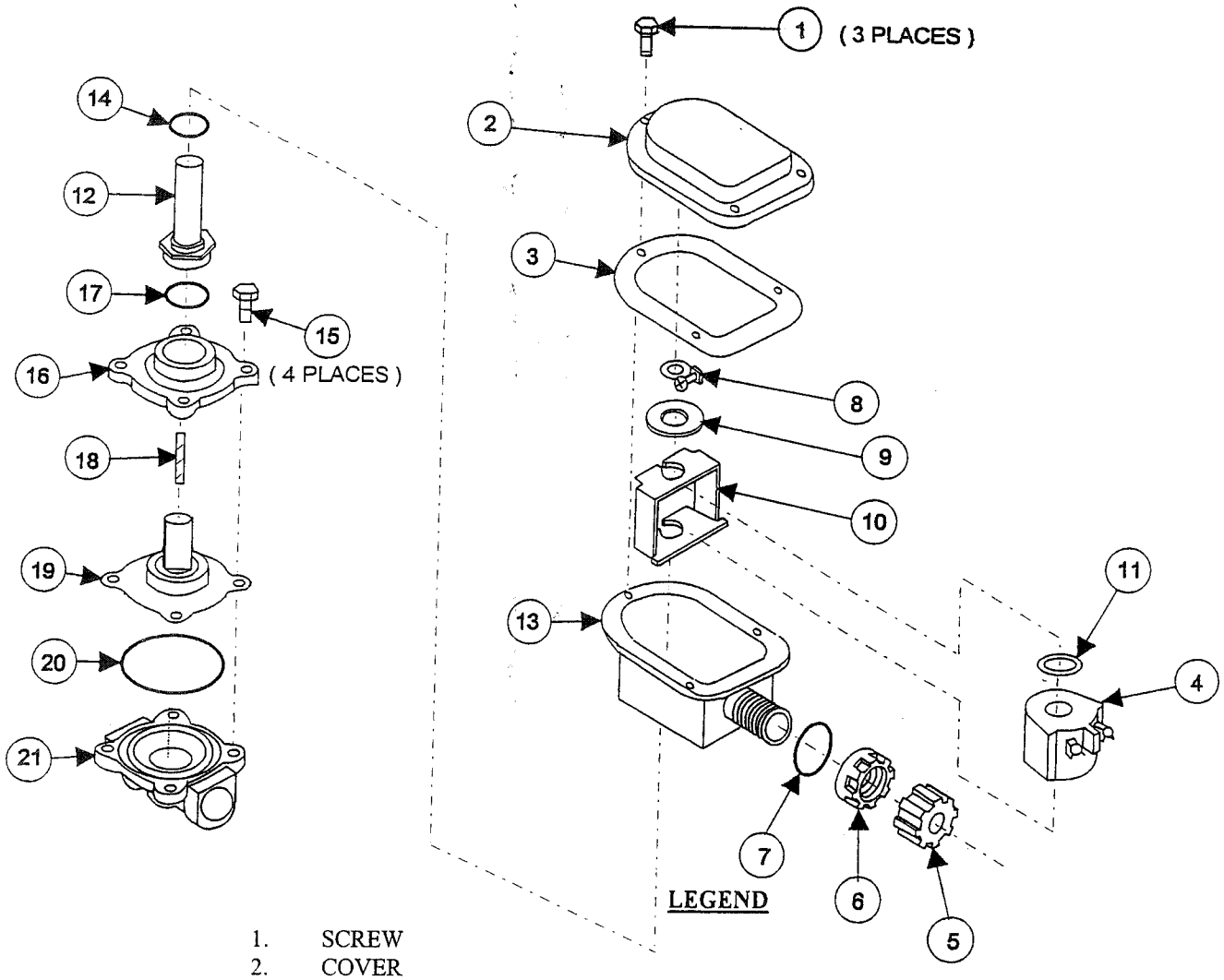
WARNING

To prevent injury or death, ensure equipment is de-energized and tagged OUT-OF-SERVICE at the source.

b) Turn OFF and lockout main power source for LPAC. Install OUT-OF-SERVICE tag.

c) Loosen three screws (1). Remove cover (2) with screws (1) attached and gasket (3).

d) Tag and disconnect wire leads from coil (4).



1. SCREW
2. COVER
3. GASKET
4. COIL
5. CAP
6. LOCKNUT
7. GASKET
8. RETAINING CLIP
9. WASHER
10. YOKE
11. SPRING WASHER
12. SOLENOID BASE SUBASSEMBLY
13. HOUSING
14. GASKET
15. SCREW
16. VALVE BONNET
17. GASKET
18. SPRING
19. CORE/DIAPHRAGM SUBASSEMBLY
20. GASKET
21. VALVE BODY

Figure 6-17. Make-Up and Drain Solenoid Valve

e) Remove cap (5). Solenoid leads can now be pulled away from coil (4) and continuity of coil checked.

f) Unscrew and remove retaining clip (8) from solenoid base subassembly (12).

g) Remove washer (9) and slip yoke (10) containing coil (4) and spring washer (11) off solenoid base subassembly (12).

h) If coil replacement was purpose of disassembly, install new coil (4) and reassemble by reversing steps above. If valve repair or cleaning is necessary, continue with steps below.

i) Close ship's potable water supply valve to LPAC.

j) Remove housing (13) and unscrew solenoid base subassembly (12) with gasket (14) attached.

CAUTION

Do not damage or distort hanger spring between core/diaphragm subassembly (19).

k) Remove four screws (15), valve bonnet (16), gasket (17), spring (18), core/diaphragm subassembly (19) and gasket (20) from valve body (21).

l) Clean valve parts in detergent solution and inspect for burrs, gouges, cracks, or other visual damage. Replace any suspect parts as well as spring (18) and gaskets (3), (7), (14), (17), and (20).

m) Lubricate all gaskets, except gasket (3), with Dow Corning III compound lubricant, or equivalent silicon grease.

n) Replace gasket (2) and core/diaphragm subassembly (19) on valve body (21). Locate bleed hole in core/diaphragm subassembly (19) approximately 45 degrees from valve outlet.

o) Install spring (18) in core/diaphragm subassembly (19) with closed end of spring protruding from top of core.

p) Replace valve bonnet (16) and install four screws (15). Torque screws in crisscross manner to 95 ± 10 in. lbs.

q) Replace gasket (17) and solenoid base subassembly (12). Torque solenoid base subassembly (12) to 175 ± 25 in. lbs.

r) Slip gasket (14) over solenoid base subassembly (12).

s) Replace gasket (7), and install locknut (6). Torque locknut to 100 in. lbs. Install cap (5).

t) Slip housing (13) and yoke (10) containing coil (4) and spring washer (11) over solenoid base subassembly (12).

u) Replace washer (9) and retaining clip (8). Tighten clip securely.

v) Make electrical hookup to coil (4).

w) Replace gasket (3), cover (2), and tighten three screws (1) to 10 in. lbs.

x) Open ship's potable water supply valve to LPAC and check valve for leaks.

y) Restore main power source to LPAC and remove OUT-OF-SERVICE tag.

z) Operate valve several times to ensure proper operation.

6-6.15.2 Blowdown Solenoid Valve. (Index numbers below refer to Figure 6-18 unless otherwise indicated.) If test of blowdown solenoid valve indicates repair or cleaning is required, disassemble valve as follows:

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

WARNING

To prevent injury or death, ensure equipment is de-energized and tagged OUT-OF-SERVICE at the source.

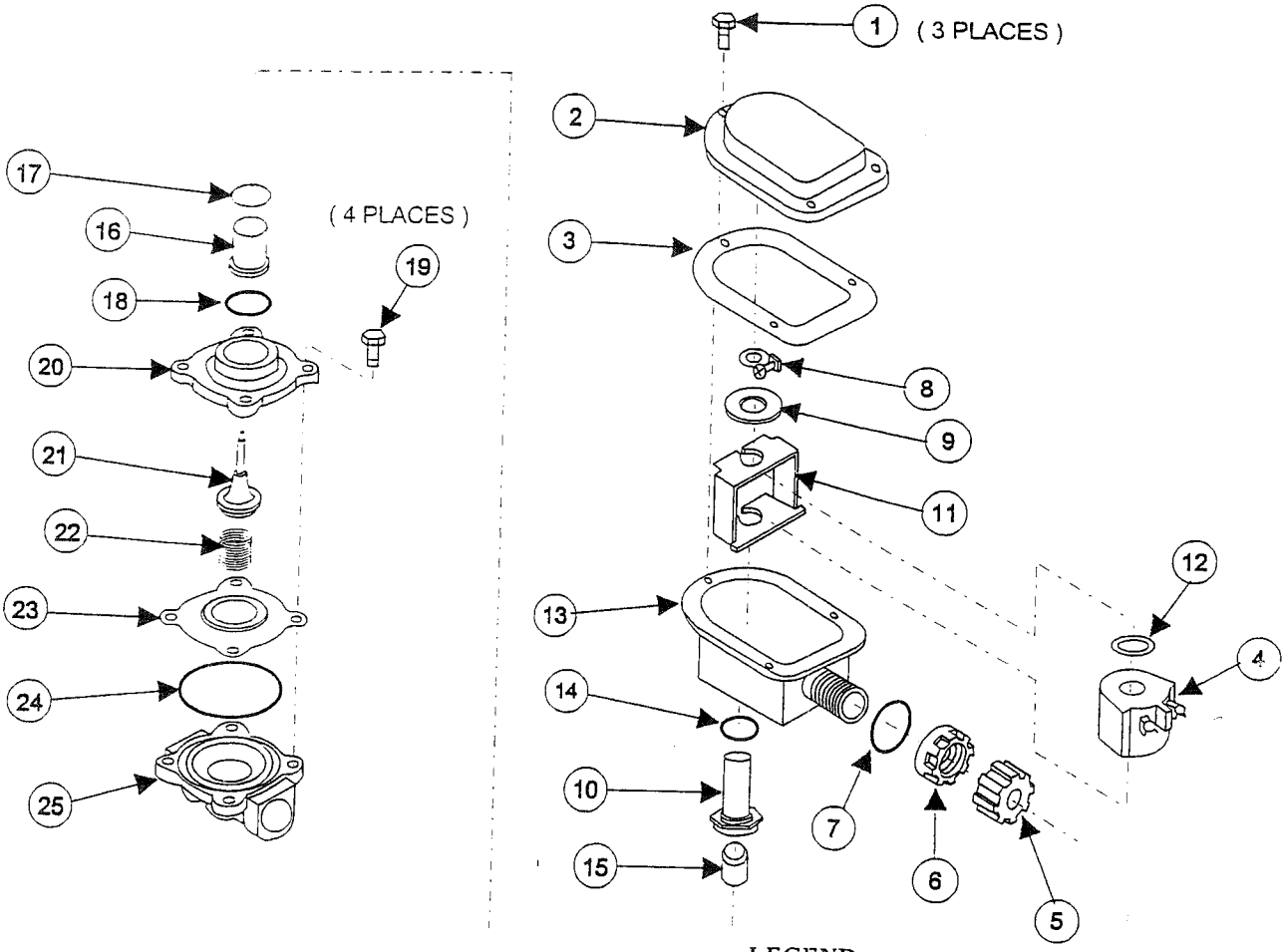
b) Turn OFF and lockout main power source for LPAC. Install OUT-OF-SERVICE tag.

c) Loosen three screws (1). Remove cover (2) with screws (1) attached and gasket (3).

d) Tag and disconnect leads from coil (4).

e) Remove cap (5). Solenoid leads can now be pulled away from coil (4) and continuity of coil (4) checked.

f) Unscrew and remove retaining clip (8) from solenoid base subassembly (10).



LEGEND

1. SCREW
2. COVER
3. GASKET
4. COIL
5. CAP
6. LOCKNUT
7. GASKET
8. RETAINING CLIP
9. WASHER
10. SOLENOID BASE SUBASSEMBLY
11. YOKE ASSEMBLY
12. SPRING WASHER
13. HOUSING
14. GASKET
15. CORE
16. PLUGNUT ASSEMBLY
17. GASKET
18. GASKET
19. SCREW
20. VALVE BONNET
21. DISC HOLDER ASSEMBLY
22. SPRIG
23. DIAPHRAGM/SPRING SUBASSEMBLY
24. GASKET
25. VALVE BODY

Figure 6-18. Blowdown Solenoid Valve

g) Remove washer (9) and slip yoke assembly (11) containing coil (4) and spring washer (12) off solenoid base subassembly (10).

h) If purpose of disassembly was coil replacement, install new coil, and reassemble by reversing steps above. If valve repair or cleaning is necessary, continue with steps below. Remove housing (13) and unscrew solenoid base subassembly (10) with gasket (14) attached.

i) Remove core (15), plugnut assembly (16), and gaskets (17 and 18).

j) Remove four screws (19), valve bonnet (20), disc holder assembly (21), spring (22), diaphragm/spring subassembly (23), and gasket (24) from valve body (25).

k) Clean valve parts in detergent solution and inspect for burrs, gouges, cracks, or other visual damage. Replace any suspected parts as well as spring (22) and gaskets (3), (7), (14), (17), (18), and (24).

NOTE

During reassembly, coat all gaskets except cover gasket (3) with Dow Corning III compound or equivalent silicone grease. Also, bleed hole in diaphragm/spring subassembly (23) should be approximately 45 degrees from valve outlet.

l) Reassemble and reinstall valve and solenoid assembly by reversing steps above. The following torque values apply:

Part	Torque Value Inch-Pounds
Screws (1)	10
Base Subassy. (10)	175 ± 25
Screws (19)	95 ± 10
Locknut (6)	100 MAX

m) Restore normal pressure to valve and check for leaks.

n) Restore main power source to LPAC and remove OUT-OF-SERVICE tag.

o) Operate valve several times to ensure proper operation.

6-6-15.3 Shut-Off Injection Solenoid Valve. (Index numbers below refer to Figure 6-19 unless otherwise indicated.) If test of shut-off injection solenoid valve indicates repair or cleaning required, disassemble valve as follows:

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

WARNING

To prevent injury or death, ensure equipment is de-energized and tagged OUT-OF-SERVICE at the source.

b) Turn OFF and lockout main power source for LPAC. Install OUT-OF-SERVICE tag.

c) Loosen three screws (1). Remove cover (2) with screws (1) attached and gasket (3).

d) Tag and disconnect leads from coil (4).

e) Remove cap (5). Solenoid leads can now be pulled away from coil (4) and continuity of coil (4) checked.

f) Unscrew and remove retaining clip (8) from solenoid base subassembly (9).

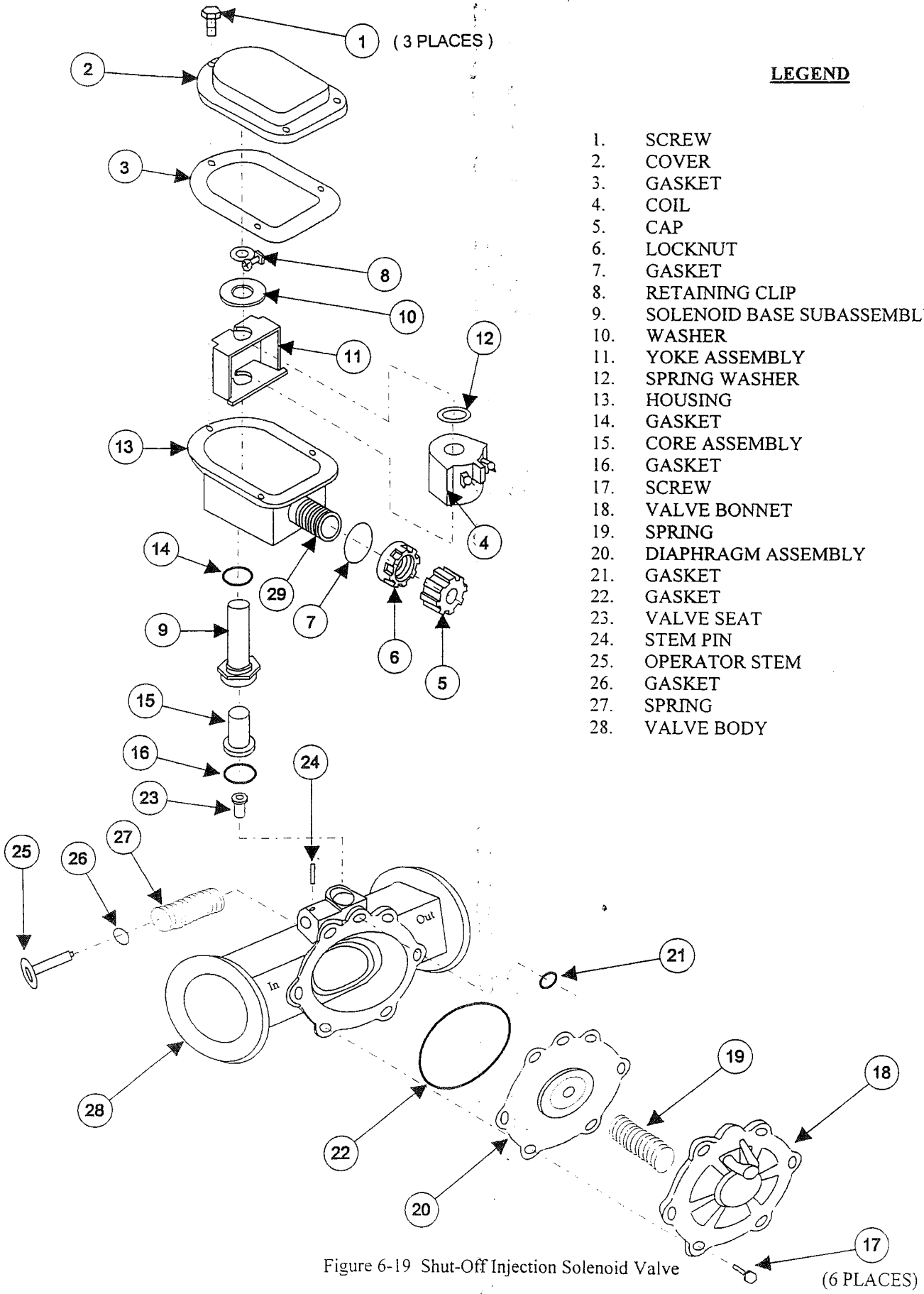
g) Remove washer (10) and slip yoke assembly (11) containing coil (4) and spring washer (12) off solenoid base subassembly (9).

h) If purpose of disassembly was coil replacement, install new coil and reassemble by reversing steps above. If valve repair or cleaning is necessary, continue with steps below.

i) Remove housing (13) and unscrew solenoid base subassembly (9) with gasket (14) attached.

j) Remove core assembly (15) and gasket (16).

k) Remove six screws (17), valve bonnet (18), spring (19), diaphragm assembly (20), gasket (21), and gasket (22).



LEGEND

1. SCREW
2. COVER
3. GASKET
4. COIL
5. CAP
6. LOCKNUT
7. GASKET
8. RETAINING CLIP
9. SOLENOID BASE SUBASSEMBLY
10. WASHER
11. YOKE ASSEMBLY
12. SPRING WASHER
13. HOUSING
14. GASKET
15. CORE ASSEMBLY
16. GASKET
17. SCREW
18. VALVE BONNET
19. SPRING
20. DIAPHRAGM ASSEMBLY
21. GASKET
22. GASKET
23. VALVE SEAT
24. STEM PIN
25. OPERATOR STEM
26. GASKET
27. SPRING
28. VALVE BODY

Figure 6-19 Shut-Off Injection Solenoid Valve

NOTE

For normal maintenance (cleaning) it is not necessary to disassemble manual operator, pieces (24) through (27). If disassembly is necessary ensure that an onboard rebuild kit is available.

l) Remove stem pin (24), operator stem (25), gasket (26), and spring (27) from valve body (28).

NOTE

For normal maintenance (cleaning) it is not necessary to remove valve seat (23). Operator assembly must be removed to remove valve seat.

m) If necessary, use 7/16" thin wall socket to remove valve seat (23).

n) Clean valve parts in detergent solution and inspect for burrs, gouges, cracks, or other visual damage. Replace any suspected parts as well as all gaskets, springs, and diaphragm assemblies.

NOTE

During reassembly, coat all gaskets except cover gasket (3) with Dow Corning III compound or equivalent silicone grease.

o) Place new gaskets (21) and (22), new diaphragm assembly (20), new spring (19), and valve bonnet (18) on valve body (28).

p) Start seven screws (17) by hand and tighten to bonnet. Then torque screws in a crisscross manner to 144 ± 15 in. lbs.

q) If manual operator was disassembled, install new gasket (26) on operator stem (25). Install new spring (27) over operator stem (25) and install this assembly in valve body (28). Then push operator stem (25) inward and install new stem pin (24).

r) If removed, coat valve seat (23) threads sparingly with Loctite PST Pipe Sealant 567 or equivalent thread sealing compound and reinstall in valve body (28). Torque valve seat to 65 ± 15 in. lbs.

s) Install new gasket (16), core assembly (15), and solenoid base assembly (9). Torque solenoid base subassembly to 175 ± 25 in. lbs.

t) Replace stuffing tube in housing (13); and position new gasket (7) and locknut (6) on stuffing tube. Torque locknut to 100 in. lbs. maximum.

u) Position new gasket (14) and housing (13) with stuffing tube assembly on solenoid base subassembly (9).

v) Position yoke assembly (11) containing coil (4) and spring washer (12) on solenoid base subassembly (9).

w) Install washer (10) and retaining clip (8). Tighten retaining clip securely.

x) Connect electrical leads to coil (4).

y) Install new gasket (3) and cover (2) with screws (1) on housing (13). Torque screws evenly to 12 ± 2 in. lbs.

z) Restore line pressure to valve and check for leaks.

aa) Restore main power source to LPAC and remove OUT-OF-SERVICE tag.

bb) Operate valve several times to ensure proper operation.

6-6.16 Servicing Separator Assembly. (Index numbers below refer to Figure 6-20 unless otherwise indicated.)

6-6.16.1 Removal of Separator from Skid. Normal servicing of separator, including replacement of float switch (20), does not require removal from skid unless insufficient overhead space exists. Removal of float switch (20) or top cover assembly (3) requires 50 1/4 inches above float switch flange (19) plus space for hoisting equipment. If necessary remove separator assembly from skid as follows:

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

WARNING

To avoid harm to personnel, LPAC must not be started with separator hoses loose or removed.

b) Turn OFF and lockout main power source. Install OUT-OF-SERVICE tag.

c) Disconnect air discharge piping at separator final air discharge connection flange (figure 1-2).

NOTE

Secure nozzle to piping.

d) Accomplish paragraph 6-6.11 steps b. through f. to disconnect injection water loop from separator assembly.

e) Disconnect compressor air end discharge piping at the separator flange (2, Figure 7-6).

f) Disconnect hoses to blowdown solenoid valve (figure 1-2) and remove 1/4" tubing at other side of valve tee.

g) Disconnect air tubing lines from top of separator.

h) Remove blowdown solenoid valve (figure 1-2) and its bracket from top of separator.

i) Disconnect support bracket (23, Figure 6-4) between water filter assembly and separator assembly.

j) Disconnect fillhoses (21) from separator tee fitting (6, Figure 7-7). Loosen fitting jam nut and rotate fitting for access to foundation nut (17).

k) Unscrew plug (18) from water level switch assembly (9).

l) Mark separator base and skid to ensure proper alignment during reassembly.

m) Tie all disconnected tubing and wiring out of way of separator removal path.

n) Remove eight foundation nuts (17). Using chain fall, lift separator off skid to area suitable for disassembly.

o) Reinstall separator using new gaskets, by reversing steps above.

p) Refill system with potable water and check for leaks.

q) Restore main source power to LPAC and remove OUT-OF-SERVICE tag.

6-6.16.2 Disassembly/Reassemby of Separator Assembly.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

WARNING

To avoid harm to personnel, LPAC must not be started with separator hoses loose or removed.

b) Turn OFF and lockout main power source for LPAC. Install OUT-OF-SERVICE tag.

c) If necessary, remove separator from skid (IAW paragraph 6-6.16.1). If removal not necessary, prepare separator for disassembly (IAW paragraph 6-6.16.2).

d) Mark float switch flange (19) and separator tank to ensure proper alignment during reassembly.

e) Remove twelve nuts (11) and six studs (12).

CAUTION

When removing float switch (20), be careful not to bend rod or chip floats.

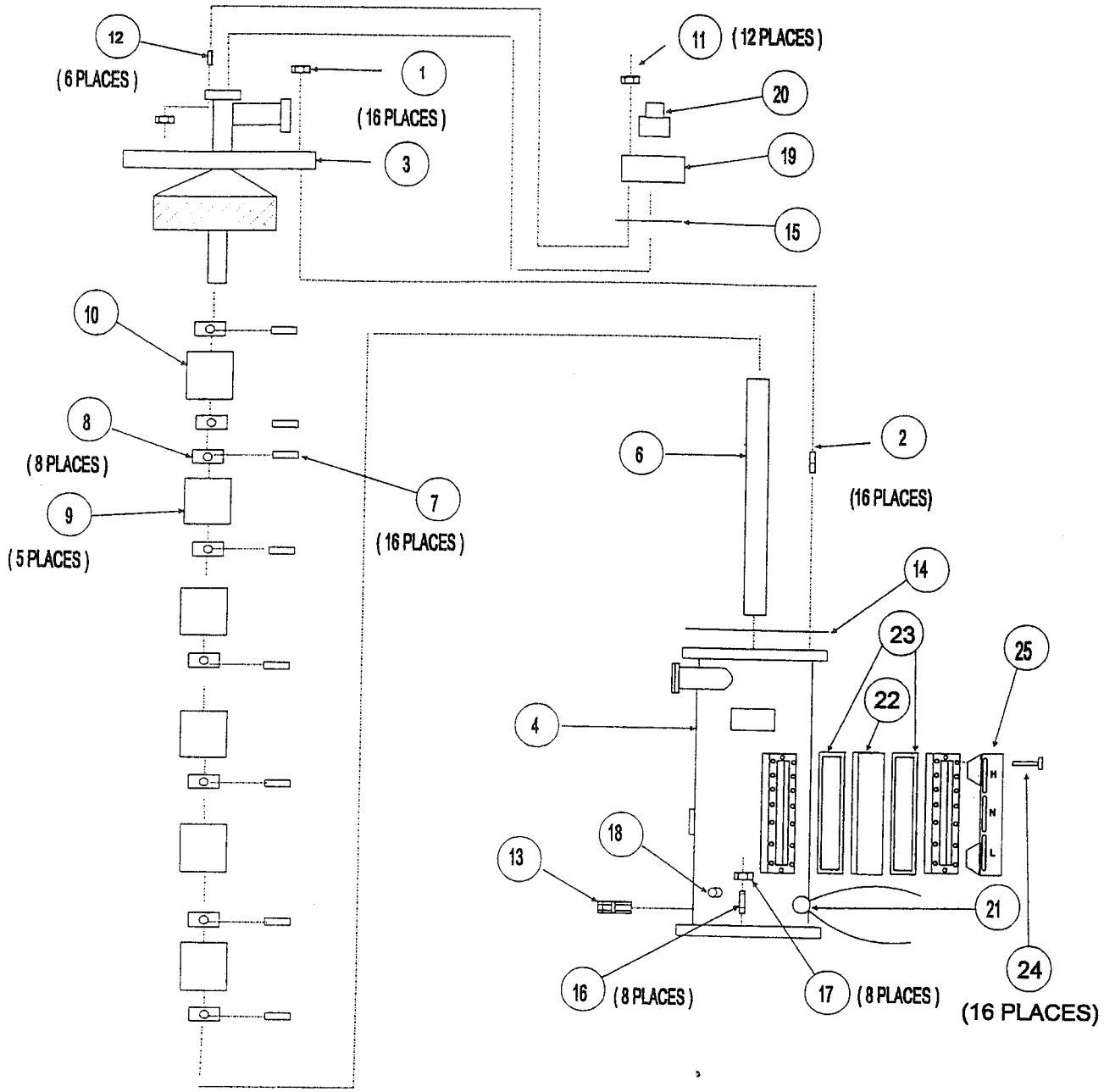
f) Lift float switch (20) straight upward until float switch (20) clears top flange of separator and set aside. Remove gasket (15).

g) If purpose of separator disassembly is to replace float switch (20), install new gasket (15) and lower replacement switch carefully into separator flange. Then reassemble and reinstall separator onto skid (if removed) by reversing steps above. Torque all nuts to value shown in table 6-1. If separator is being disassembled for other than replacement of float switch (20), continue as follows:

h) Remove sixteen nuts (1) from studs (2).

CAUTION

To avoid damage, only an experienced hoist operator should be allowed to move heavy components.



LEGEND

1. NUT
2. STUD
3. TOP COVER ASSEMBLY
4. HOUSING
5. (NOT USED)
6. STEM WELDMENT
7. SET SCREW
8. COLLAR
9. WATER LEVEL SWITCH ASSEMBLY
10. DUMMY FLOAT
11. NUT
12. STUD
13. CHECK VALVE (REFERENCE)
14. GASKET
15. GASKET
16. STUD
17. FOUNDATION NUT
18. PLUG
19. FLOAT SWITCH FLANGE
20. FLOAT SWITCH
21. FILLHOSES (REFERENCE)
22. SIGHT GLASS
23. GASKET
24. CAPSCREW
25. LEVEL GAUGE

Figure 6-20. Separator Assembly for LPAC.

i) With all connections to top of separator broken, tubing and lines tied out of way, and hoist in readiness:

1) Install two studs (2) into opposing holes of float switch flange (19). Thread nuts (1) onto each stud (2).
2) Wrap a loop of the hoisting sling under the float switch flange (19). Use the installed studs (2) to keep sling from slipping off float switch flange (19) during lift.
3) Take a strain on the hoisting sling and lift separator top straight up until stem weldment (6) has cleared housing (4). The conical air deflector assembly must not be allowed to cock in the separator tank as it is being withdrawn. Set separator top assembly aside.

j) Remove gasket (14).

k) Clean components with detergent and a bristle brush, then flush with potable water.

l) Remove sixteen capscrews (24), level gauge (25), sight glass (22), and gasket (23).

m) Reassemble separator and reinstall using new gaskets (23) by reversing steps above. Torque all nuts, except capscrews (24), to value shown in table 6-1. Torque capscrews (24) in five ft. lb. increments. Tighten from center towards outside edge (top and bottom) to final torque of 30 ft. lbs. This sequence is necessary to prevent cracking of sight glass (22).

n) Refill system with potable water and check for leaks.

o) Restore source power to LPAC and remove OUT-OF-SERVICE tag.

p) Operate LPAC and check for high pressure leaks.

6-6.17 Replacing Pressure Transducer. To replace a defective pressure transducer, refer to Figure 6-1 and proceed as follows:

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set MAN/AUTO selector switch (4, Figure 2-1) to MAN.

Delete and re sequence subsequent steps. Re: The new style transducers do not have ground straps.

r source for LPAC.

transducer being replaced, disconnect tubing line to transducer below tee.

d) Disconnect grounding strap, if installed on transducer.

e) Tag and disconnect electrical leads to transducer being replaced.

f) Remove defective transducer by removing attaching bolts and washers.

Delete this step. Per paragraph 6-3.3, there is no above adjustment foe the new style transducers.

h) Restore main source power to LPAC and remove OUT-OF-SERVICE tag.

i) Calibrate transducer (IAW paragraph 6-3.3).

6-6.18 Repair of Heat Exchanger. . (Index numbers below refer to Figure 6-21 unless otherwise indicated.) Disassemble heat exchanger only to point necessary to make needed repair or inspection. From that point, reassemble by reversing steps already accomplished

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

b) Turn OFF and lockout main power source for LPAC. Install OUT-OF-SERVICE tag.

c) Close ship's seawater supply valve to heat exchanger.

d) Close ship's potable water supply valve to LPAC.

e) Open heat exchanger seawater drain valve (figure 1-2) and drain heat exchanger.

f) Open filter drain valve (13, Figure 2-2) and separator valve (15, Figure 2-2). Drain potable injection water loop.

g) Disconnect piping to two heat exchanger seawater flanges (1) and remove flange gaskets. Reference (29, 30, 39, 40, and 41 figure 7-6).

h) Disconnect piping to two heat exchanger potable water flanges (2) at fitting.

i) Disconnect leads to seawater inlet and outlet temperature RTD's (figure 1-2).

NOTE

Be prepared for residual water discharge when tubing disconnected.

j) Disconnect tubing lines to seawater pressure gauge panel at spool piece. Remove flexible hosing to heat exchanger.

k) Remove mounting nuts (3), studs (22), washers (23), sleeves (24), and isolator blocks (25).

CAUTION

To avoid damage,only an experienced hoist operator should be allowed to move heavy components Heat exchanger is very heavy.

NOTE

Be prepared for residual water discharge when removing heat exchanger.

l) Remove heat exchanger to work area.

CAUTION

Never open heat exchanger when it is hot. The unit should be cooled to room temperature before opening to prevent loosening of gaskets.

m) Remove four shroud nuts (4) and shroud washers (5) and lift-off shroud (6).

n) Loosen four bolt assemblies (8) in left-right sequence at 1/4" increments until they can be lifted out. Remove outer locknuts (8A), then inner nuts.

o) Slide movable frame (9) out upper and lower guide bars (10 and 11) until it rests against stop bolt (7).

NOTE

Heat exchanger plates are numbered 1-31 from flanged end of heat exchanger. Keep plates in numerical order during reassembly.

p) Slide plate assemblies (13, 14, 15, and 16) out upper and lower guide bars (10 and 11). Inspect each plate and "A/B" gasket (20) for lime deposits, dirt, corrosion, and damage. Lower portion of plate should be inspected carefully as this is where residual solid material tends to accumulate.

CAUTION

Do not use steel brush or wool to clean plates. If brush is required, a fiber type is recommended. If absolutely necessary to use steel brush, a stainless steel brush is recommended. Be careful not to scratch gasket surfaces.

q) As each plate assembly (13, 14, 15, and 16) is slid out, clean it as follows:

1) Brush each plate and rinse with clean water.
2) Wipe gaskets dry with a cloth. Remove any solid particles adhering to gasket to preclude damage or leaks when unit is reassembled.
3) Wipe off mating surface, i.e., rear of plate where gasket seats.

r) If necessary, remove plate assemblies (13, 14, 15 and 16) for additional cleaning or repair as follows:

1) Remove stop bolt (7).

WARNING

Plate assemblies (13, 14, 15 and 16) are sharp. Wear leather gloves and exercise care when handling plate assemblies.

2) Tilt plate assembly and slide it off upper and lower guide bars (10 and 11).

s) When necessary, replace gasket (20) as follows:

1) Remove plate assembly (13, 14, 15, and 16) and lay it on clean, flat, horizontal surface.
2) Using a screwdriver, pry "A/B" gasket (20) up far enough to get finger under it. Then slowly pull gasket from plate groove.
3) Clean adhesive residue and other foreign matter from groove. Wipe dry.

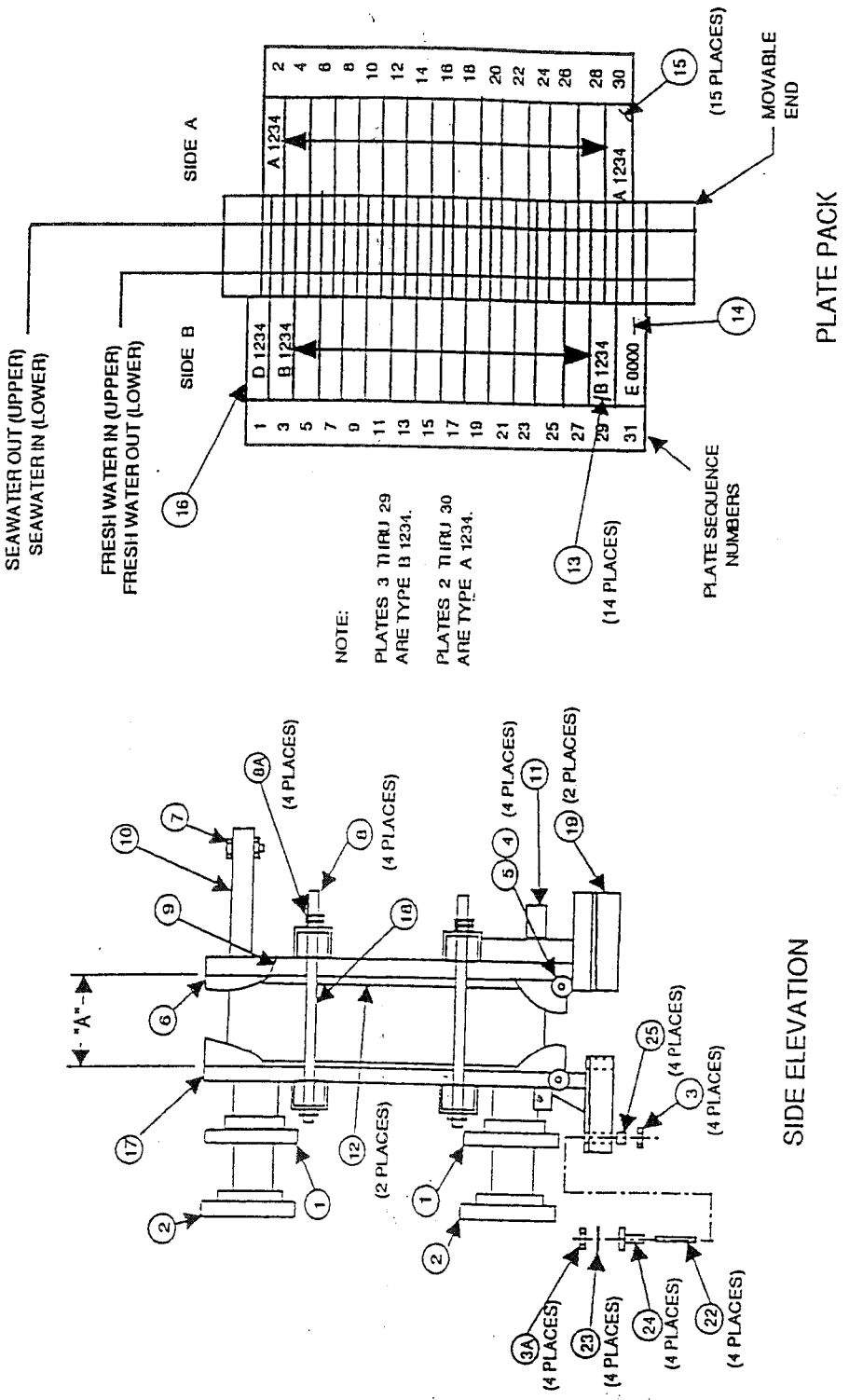
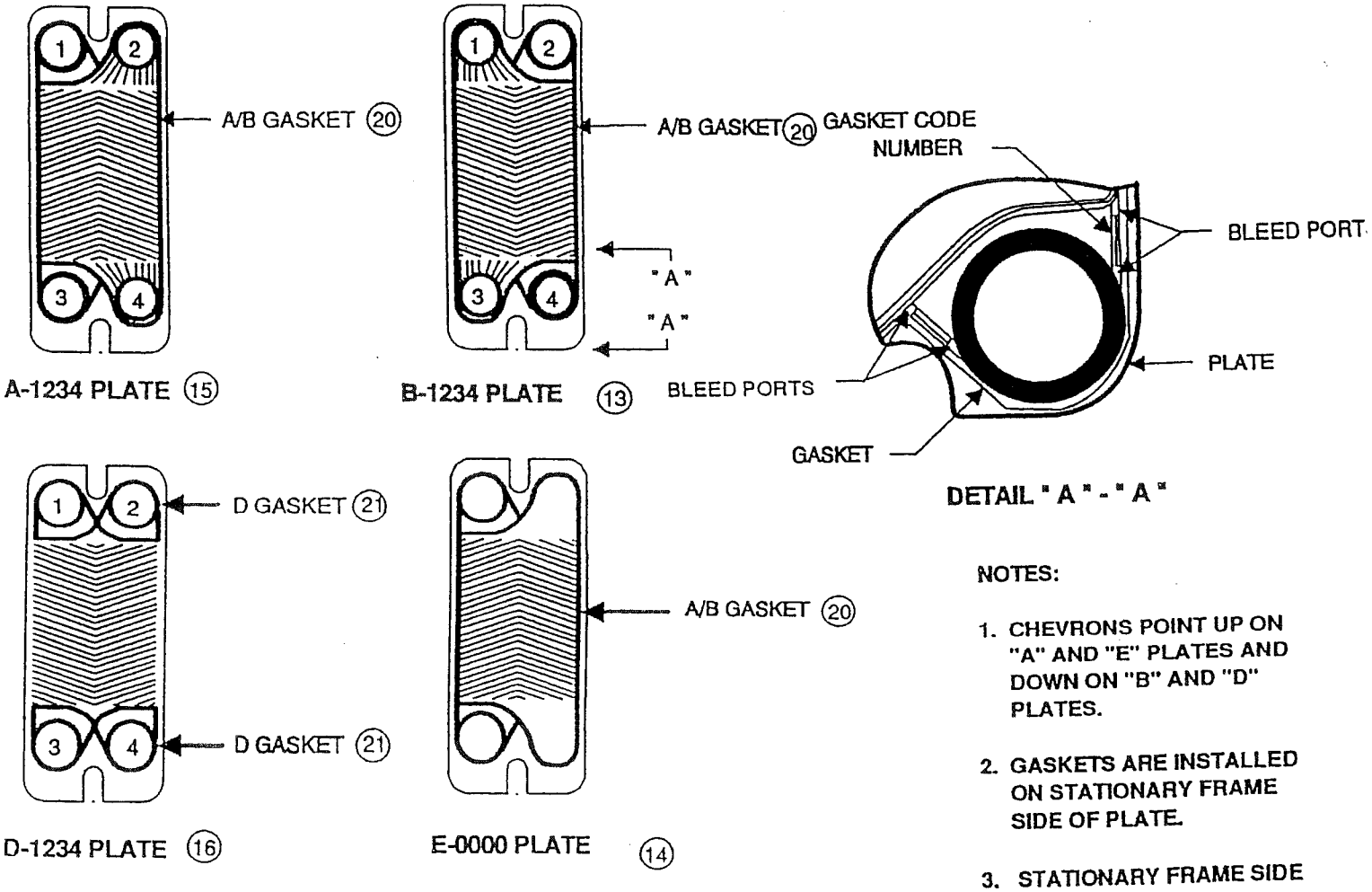


Figure 6-21. Heat Exchanger (sheet 1 of 2)



NOTES:

1. CHEVRONS POINT UP ON "A" AND "E" PLATES AND DOWN ON "B" AND "D" PLATES.
2. GASKETS ARE INSTALLED ON STATIONARY FRAME SIDE OF PLATE.
3. STATIONARY FRAME SIDE OF PLATES SHOWN.
4. D-1234 PLATE (16) USES SPECIAL GASKET (21).

1. SEAWATER FLANGE
2. WATER FLANGE
3. MOUNTING NUTS
3A. MOUNTING NUTS
4. SHROUD NUTS
5. SHROUD WASHER
6. SHROUD
7. STOP BOLT
8. BOLT ASSEMBLY
8A. LOCKNUT
9. MOVABLE FRAME
10. UPPER GUIDE BAR
11. LOWER GUIDE BAR
12. INSULATOR
13. B-1234 PLATE ASSEMBLY
14. E-0000 PLATE ASSEMBLY
15. A-1234 PLATE ASSEMBLY
16. D-1234 PLATE ASSEMBLY
17. STATIONARY FRAME
18. STOP GAUGE
19. REMOVABLE BASE PLATE
20. A/B GASKET
21. D GASKET
22. STUD
23. WASHER
24. SLEEVE
25. ISOLATOR BLOCK

Figure 6-21. Heat Exchanger (sheet 2 of 2)

CAUTION

Do not apply excessive adhesive. Adhesive should not ooze out when gasket is pressed into groove.

4) Apply uniform layer of Pliobond 20/30 or equivalent adhesive to plate groove.

NOTE

"D" plate (16), next to stationary frame (17) requires different gasket. Install special "D" gasket (21).

5) Position "A/B" gasket (20) on plate so that recess in gasket at bleed passage location is up. Ensure gasket code number is visible in bleed passage area.
6) Using finger pressure, press "A/B" gasket (20) into same groove gasket was removed from.
7) Compress gasket by placing the plate under weighted sheet of wood. Leave compressed and allow gasket to cure for a minimum of twelve hours.
8) Using solvent, remove any excess adhesive.

NOTE

When reassembling plates on heat exchanger, ensure they are installed in numerical order from 1 to 31 beginning from flanged end of exchanger. Plates are installed with gasket side facing stationary frame.

t) Install "D" (16) first, positioning it against station frame (17) with gasket side against frame. Next install "A" and "B" plates numbers 2 through 30. Gasket side of "A" plate number 2 should be against "D" plate number 1. Plates must be alternated between "A" and "B" types (refer to Figure 6-20). Finally install "E" plate assembly (14).

u) After plate assemblies have been installed (alternating "A" and "B" in numerical sequence) slide movable frame (9) toward plates assemblies.

NOTE

Ensure that notch in stop gauge (18) is lined up with brace on bolt.

v) Reinstall locknuts (8A) on bolts (8) tightening in a clockwise rotation. Tighten until dimension "A" in figure 6-10 is 3-15/16" +/- 1/16" or until movable frame hits stop gauge (18). Then reinstall lock nuts.

w) Reinstall shroud (6) washer (5) and shroud nuts (4).

x) Reverse steps a. through j. above to reinstall heat exchanger.

6-6.19 Maintenance of Pneumatic Pilot Valve. (Index numbers below refer to Figure 6-22 unless otherwise indicated.)

6-6.19.1 Disassembly.

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN.**

WARNING

To avoid harm to personnel, LPAC must not be started with pilot valve loose or removed.

b) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.

c) Turn OFF and tag OUT-OF-SERVICE system LPAC air supply valve to low pressure accumulator.

WARNING

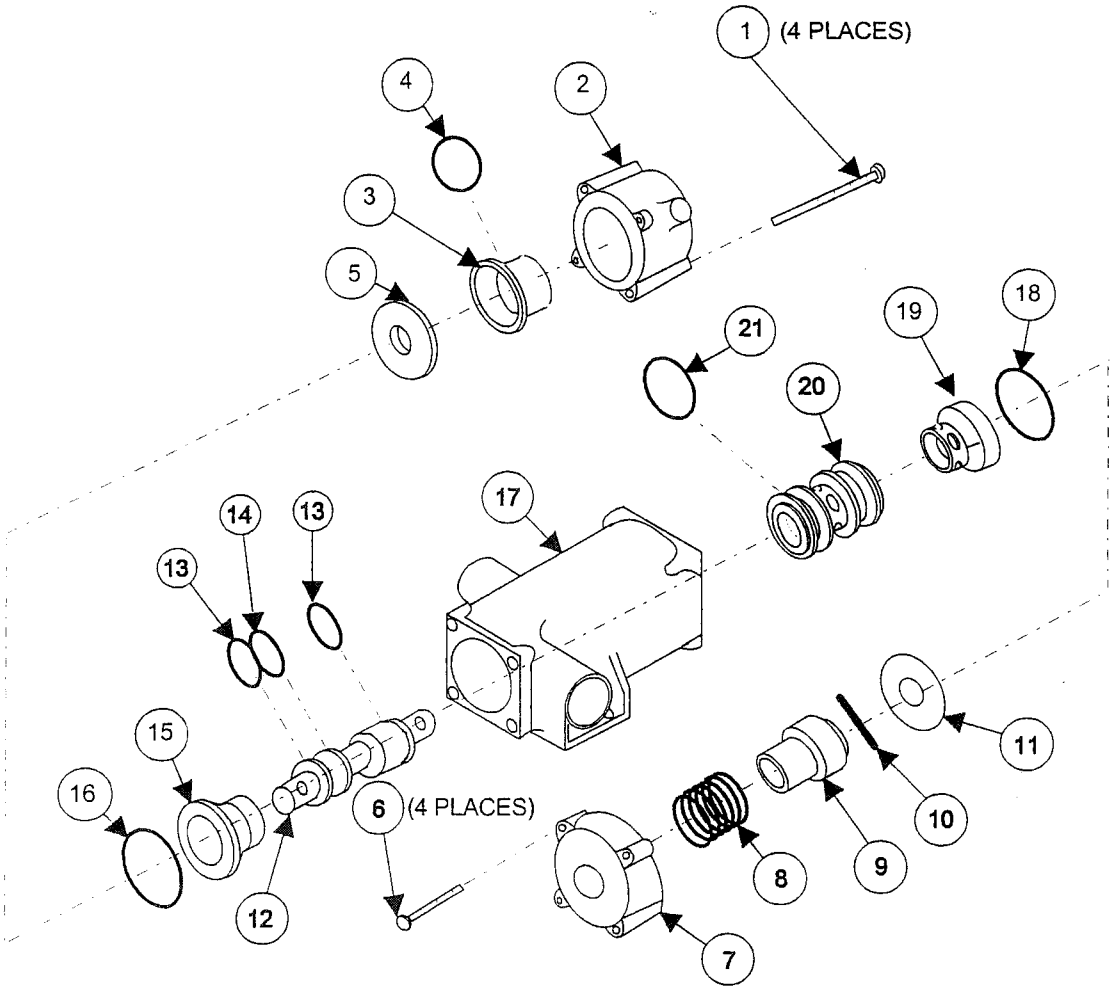
Pressure air is dangerous. Always vent all pressure before working on or disconnecting pressure piping.

d) Disconnect tubing and hoses attached to pneumatic pilot valve. Disconnect and remove pneumatic pilot valve assembly (18, Figure 7-7).

e) Remove four screws (1) from pilot cap (2) of valve.

f) Remove pilot cap (2); piston (3) with o-ring (4) attached; and washer (5) from valve body (17). Remove o-ring (4) from piston (3). Install new o-ring during reassembly.

g) Remove four screws (6) from spring cap (7).



LEGEND

1.	SCREW	8.	SPRING	15.	BEARING
2.	PILOT CAP	9.	SPRING CUP	16.	O-RING
3.	PISTON	10.	PIN	17.	VALVE BODY
4.	O-RING	11.	WASHER	18.	O-RING
5.	WASHER	12.	PLUNGER	19.	RETAINER
6.	SCREW	13.	70 DUROMETER O-RING	20.	BUSHING
7.	SPRING CAP	14.	90 DUROMETER O-RING	21.	O-RING

Figure 6-22. Pneumatic Pilot Valve

h) Remove spring cap (7), spring (8), and spring cup (9) from valve body (17).

i) Remove pin (10) and washer (11) from plunger assembly (12, 13, and 14.)

j) Remove bearing (15) and o-ring (16) from valve body (17). Install new o-ring during reassembly.

k) Remove plunger (12) together with o-rings (13 and 14) from valve body (17). Remove o-rings (13 and 14) from plunger (12). Install new o-rings during reassembly.

l) Remove o-ring (18), retainer (19), and bushing (20) with o-ring (21) attached from valve body (17). Remove o-ring (21) from bushing (20). Install new o-rings during reassembly.

6-6.19.2 Repair and Reassembly.

NOTE

Install new o-rings and burnish out any minor metal burrs whenever valve is disassembled.

a) Install new o-ring (21) into groove of bushing (20). Insert bushing sub-assembly (20 and 21) into valve body (17) ensuring end containing o-ring (21)is placed in first.

c) Insert retainer (19) and new o-ring (18) into valve body (17).

d) Insert bearing (15) and new o-ring (16) into valve body (17).

e) Install new 70 Durometer o-rings (13) into grooves on ends of plunger (12). Install new 90 Durometer o-ring (14) into remaining groove on plunger (12).

f) Insert plunger sub-assembly (12, 13, and 14) into valve body (17) ensuring to hold retainer (19) tightly in place.

g) Install washer (5) over plunger (12) end extending from valve body (17).

h) Install new o-ring (4) in groove of piston (3). Insert piston sub-assembly (3 and 4) into bore of pilot cap (2) ensuring that hole faces valve body.

i) Install pilot cap sub-assembly (2, 3, and 4) over plunger (12) end extending from valve body (17).

j) Install and tighten four screws (1).

k) Install washer (11) over plunger (12) end extending from valve body (17).

l) Install pin (10) through small hole in plunger (12).

m) Install spring cup (9) and spring (8) over plunger (12) end extending from valve body (17).

n) Position spring cap (7) over spring (8).

o) Compress spring (8) until spring cap (2) bottoms on valve body (17). Then install and tighten four screws (6).

p) Reinstall and reconnect valve assembly. Then remove OUT-OF-SERVICE tags, and restore LPAC to operation.

q) Check valve assembly for leaks when LPAC is next started.

6-6.20 Maintenance of Ball Valves. (The index numbers below refer to Figure 6-23 unless otherwise indicated.) This paragraph covers maintenance of three types of ball valves (23, 24, and 28, Figure 7-7).

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

WARNING

To avoid harm to personnel, LPAC must not be started with valve connections loose or hoses removed.

b) Turn OFF and lockout main power source for LPAC. Install OUT-OF-SERVICE tag.

c) Determine type of liquid being controlled by valve being maintained. Turn off ship's valve controlling source of liquid to LPAC and drain LPAC of stored liquid.

NOTE

Be prepared for discharge of residual liquid when valve hoses are disconnected.

d) Disconnect hoses at valve being maintained and remove valve.

LEGEND

1. NUT
2. SPRING WASHER
3. NAMEPLATE
4. STOP PLATE
5. HANDLE
6. SPRING
7. NUT
8. SPRING WASHER
9. SPRING WASHER
10. GLAND
11. PACKING SUPPORT
12. TOP PACKING
13. BOTTOM PACKING
14. NUTS
15. FLANGE
16. O-RING
17. SPRING
18. SEAT
19. SUPPORT RING
20. BOLTS
21. FLANGE
22. O-RING
23. SPRING
24. SEAT
25. SUPPORT RING
26. BALL
27. STEM
28. BEARING
29. BEARING
30. CENTER BODY

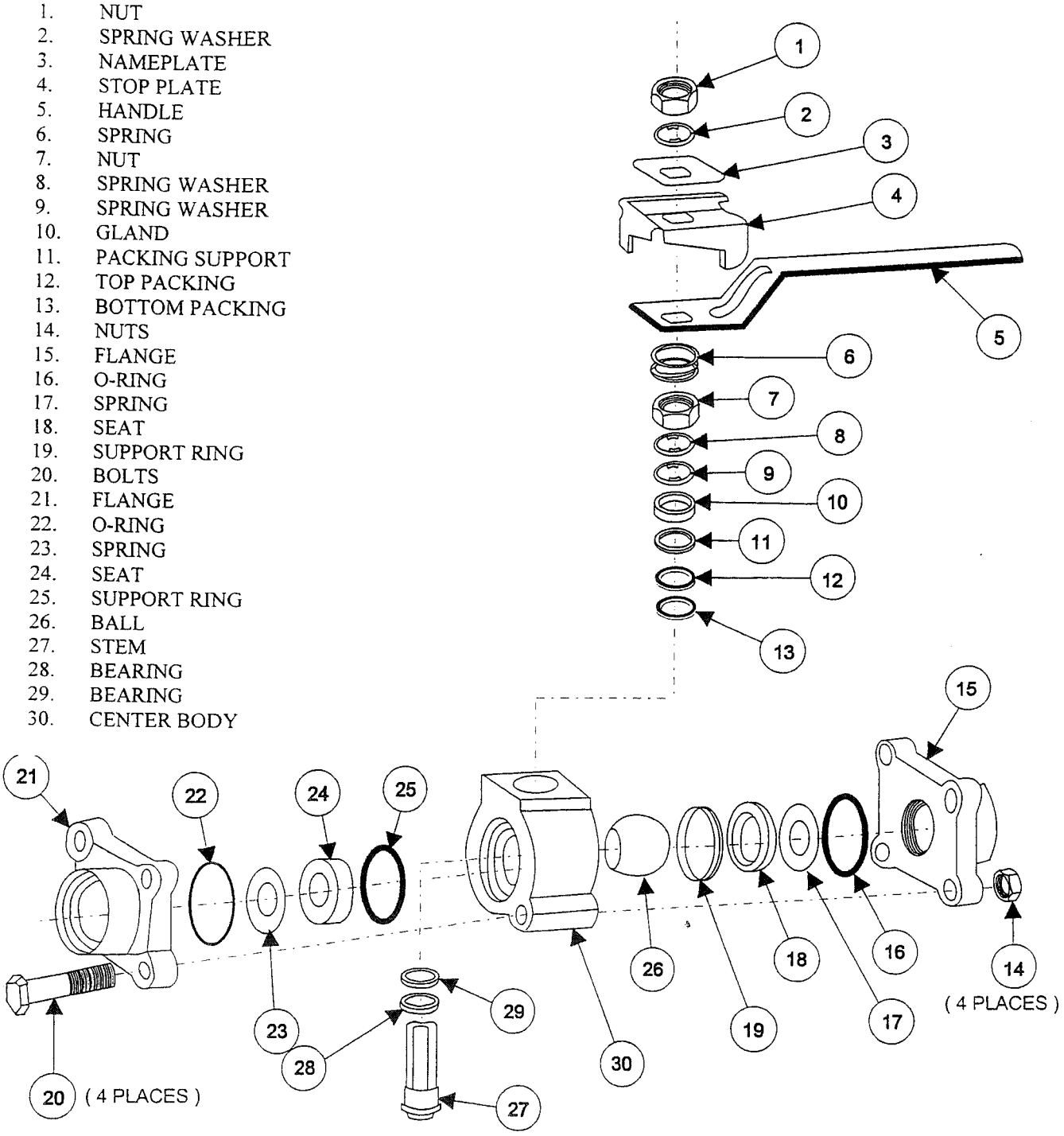


Figure 6-23. Ball Valve

e) Remove nut (1), spring washer (2), nameplate (3), stop plate (4), handle (5), and spring (6).

f) Remove nut (7), spring washer (8), spring washer (9), gland (10), packing support (11), and top and bottom packings (12 and 13) from center body (30).

g) Remove four nuts (14).

h) Remove flange (15), o-ring (16), spring (17), seat (18), and support ring (19).Remove four bolts (20).

i) Remove flange (21), o-ring (22), spring (23), seat (24), and support ring (25).

j) Remove ball (26) with stem (27), bearings (28 and 29) attached from center body (30).

k) Remove stem (27) and bearings (28 and 29) from ball (26).

l) Clean all parts in detergent solution. Inspect for nicks, grooves, or other visual signs of damage.

m) Reassemble and reinstall valve by reversing steps above. Install new o-rings (22) and springs (17 and 23) during reassembly. Lubricate top and bottom packings (12 and 13), seats (18 and 24) and o-rings (16 and 22) with a silicone base lubricant. Lubricate bearings (28 and 29) with a TFE base lubricant during reassembly.

n) Replace any drained LPAC liquids and check valve for leaks.

o) Restore source power to LPAC and remove OUT-OF-SERVICE tag.

6-6.21 Replacement of Temperature Transducers. The four temperature transducers are not repairable. Replace a defective transducer as follows:

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.

b) Set **CONTROL POWER ON/OFF** selector switch (5, Figure 2-1) to **OFF**.

c) Refer to FO-2, sheet 1 for location of transducer. Then disconnect wiring harness from the transducer being replaced.

d) If seawater or potable water temperature transducers are being replaced, turn OFF seawater or potable water supply valves (as appropriate) to LPAC.

b) If air temperature transducer is being replaced, bleed off residual LPAC air pressure.

NOTE

Be prepared for discharge of residual liquid when water temperature transducers are removed.

f) Remove transducer (1, Figure 7-10) and associated o-ring (9, Figure 7-10).

g) Install replacement transducer by reversing steps above, using a new o-ring.

6-6.22 Replacement of Differential Pressure Gauge. (Index numbers below refer to Figure 7-13 unless otherwise noted.) The differential pressure gauge is not repairable. Replace the gauge as follows:

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**

b) Set **CONTROL POWER ON/OFF** selector switch (5, Figure 2-1) to **OFF**.

c) Loosen connectors (5) on top of differential pressure gauge (1).

d) Remove capscrews (8) and nuts (9) from bracket (2). Remove differential pressure gauge.

e) Install new differential pressure gauge by reversing steps above, using new O-rings (10 and 11).

6-7 PROGRAMMABLE LOGIC CONTROLLER (PLC) REPLACEMENT PROCEDURES.

This section covers PLC replacement procedures. Replacement procedures are listed in order of subassembly removal. Figure 6-24 provides a reference of subassembly locations. Failure to adhere to the following specific instructions and all cautions can result in equipment damage.

6-7.1 Programmable Logic Controller (PLC) Replacement. (Refer to Figure 6-24 unless indicated otherwise.)

CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

a) Set MAN/AUTO selector switch (4, Figure 2-1) to MAN.

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

NOTE

Attach wrist ground strap or equivalent prior to handling ESD items.

b) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.

c) Set ON/OFF selector switch (9, Figure 6-24) to OFF.

6-7.1.1 Control Panel Assembly and Components Replacement. (Refer to Figure 6-24 unless indicated otherwise.)

6-7.1.1.1 Control Panel Assembly Replacement. (Refer to Figure 6-24 unless indicated otherwise.)

a) To replace control panel assembly (1) proceed as follows:

1) Using 1/8" Allen wrench remove eighteen button head bolts (2) and eighteen washers (3).
2) Using flat blade screwdriver, disconnect cable that attaches to underside of touchscreen display (19).
3) Tag and disconnect wires from all switches (9, 10, 11, and 12), MOTOR RUNNING Indicator Light (13), WARN/FAIL Indicator Light (14) and hours meter (15).
4) Remove control panel assembly (1) and control panel gasket (4).
5) Reverse steps above to install replacement control panel assembly (1).

6-7.1.1.2 Switch and Bulb Replacement. (Refer to Figure 6-24 unless indicated otherwise.)

a) To replace ON/OFF selector switch (9), MAN/AUTO selector switch (10), START pushbutton switch (11) or STOP/RESET pushbutton switch (12) proceed as follows:
   1) Perform step 1 under Paragraph 6-7.1.1.1.
   2) Gently flip control panel assembly (1) on its back.
   3) Tag and disconnect wires from switch to be replaced.
   4) From top of panel remove round metal bezel.
   5) From bottom of panel loosen nut securing switch and remove switch.
   6) Reverse steps above to install replacement switch.

NOTE

The MOTOR RUNNING and WARN/FAIL indicator lights both require 120VAC bulbs.

b) To replace MOTOR RUNNING or WARN/FAIL bulbs (41), unscrew red or green bulb housing from top of control panel, give bulbs a half-turn and remove. Install new bulbs by reversing this step.

6-7.1.1.3 Hours Meter Replacement. (Refer to Figure 6-24 unless indicated otherwise.)

a) To replace hours meter (15) proceed as follows:
   1) Perform steps 1 through 3 under Paragraph 6-7.1.1.2.
   2) Using a NO. 0 Phillips head screwdriver, remove two bolts (16) securing hours meter (15) to hours meter mounting bracket (17) and remove hours meter (15).

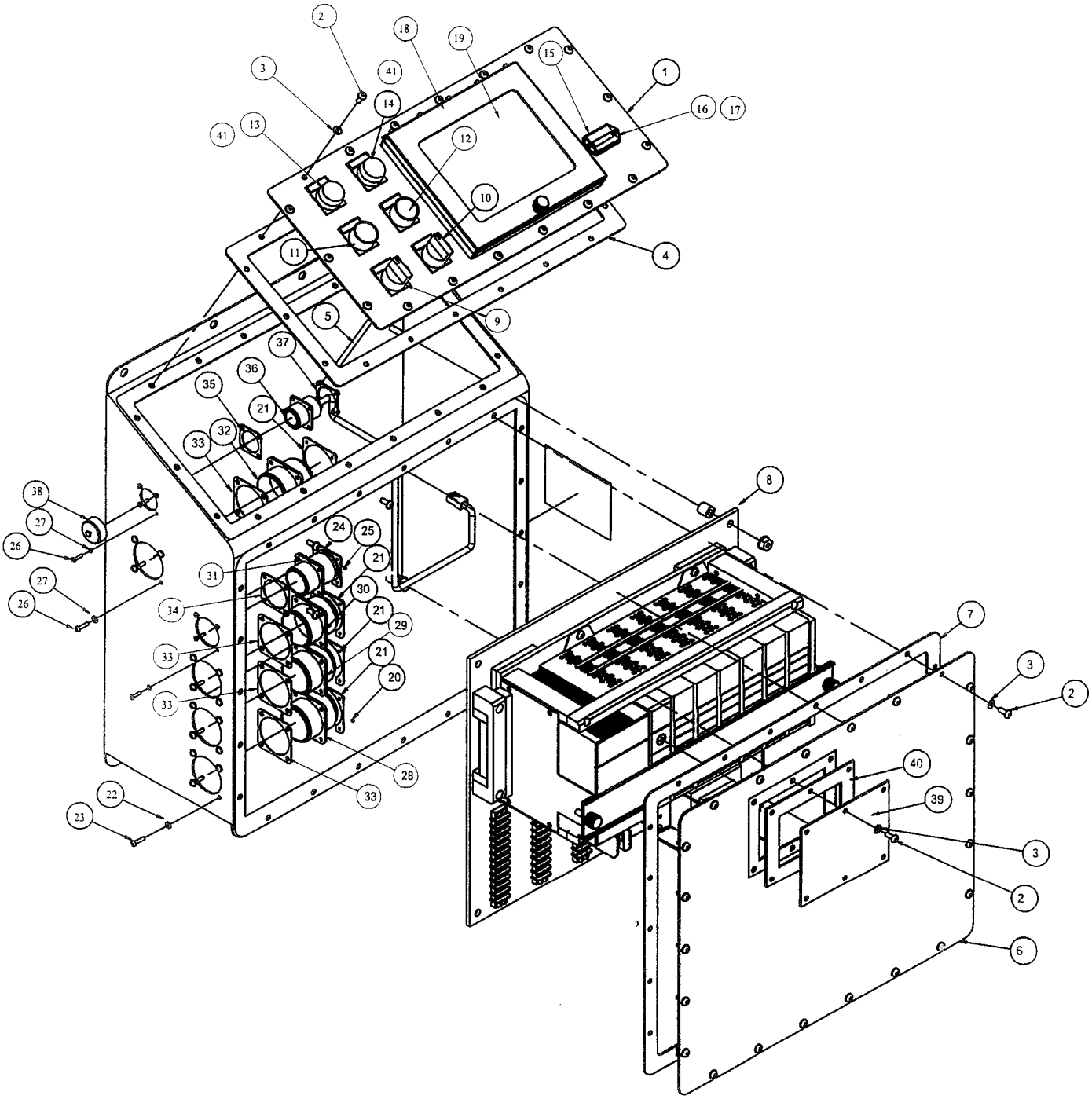


Figure 6-24 Programmable Logic Controller (PLC) (sheet 1 of 2)

LEGEND

1. CONTROL PANEL ASSEMBLY
2. BUTTON HEAD BOLT
3. WASHER
4. CONTROL PANEL GASKET
5. CABLE
6. FRONT COVER
7. FRONT COVER GASKET
8. PLC ELECTRICAL PANEL ASSEMBLY
9. ON/OFF SELECTOR SWITCH
10. MAN/AUTO SELECTOR SWITCH
11. START PUSHBUTTON SWITCH
12. STOP/RESET PUSHBUTTON SWITCH
13. MOTOR RUNNING INDICATOR LIGHT
14. WARN/FAIL INDICATOR LIGHT
15. HOURS METER
16. BOLT
17. HOURS METER MOUNTING BRACKET
18. DISPLAY COVER
19. PLC TOUCHSCREEN DISPLAY
20. NUT
21. MOUNTING FLANGE
22. WASHER
23. BOLT
24. MOUNTING FLANGE
25. NUT
26. BOLT
27. WASHER
28. ELECTRICAL CONNECTOR
29. ELECTRICAL CONNECTOR
30. ELECTRICAL CONNECTOR
31. ELECTRICAL CONNECTOR
32. ELECTRICAL CONNECTOR
33. GASKET
34. GASKET
35. GASKET
36. J6 ETHERNET CABLE ASSEMBLY
37. MOUNTING FLANGE
38. CONNECTOR CAP AND CHAIN
39. ACCESS COVER
40. ACCESS COVER GASKET
41. 120VAC BULB

Figure 6-24. Programmable Logic Controller (PLC) (sheet 2 of 2)

3) Reverse steps above to install replacement hours meter (15).

6-7.1.1.4 Touchscreen Display/Cover Replacement. (Refer to Figure 6-24 unless indicated otherwise.)

NOTE

Attach wrist ground strap or equivalent prior to handling ESD items.

a) To replace PLC touchscreen display (19) or display cover (18) proceed as follows:

1) Perform steps 1 and 2 under Paragraph 6-7.1.1.2.
2) Open display cover (18) and using a 5/32" Allen wrench remove four hex head screws securing display cover (18) to control panel assembly (1). Remove display cover (18).
3) Ensuring cable (5) is disconnected from bottom of touchscreen display (19), remove PLC touchscreen display (19) from top of control panel assembly (1).
4) Reverse steps 2 and 1 above to install replacement display cover (18).
5) Reverse steps 3 through 1 above to install replacement PLC touchscreen display (19).

6-7.1.2 PLC Controller Assembly Replacement. (Refer to Figure 6-24 unless indicated otherwise.)

6-7.1.2.1 PLC Control I/O Modules Replacement. (Refer to Figure 6-24 unless indicated otherwise.)

a) To replace PLC control (I/O) modules perform steps a, b, and c under Paragraph 6.7.1 and proceed as follows:

1) Remove thirty button head bolts (2) and washers (3) securing front cover (6).

NOTE

Attach wrist ground strap or equivalent prior to handling ESD items.

2) Lift off front cover (6) and front cover gasket (7) exposing PLC electrical panel assembly (8).
3) Remove two screws (1, Figure 6-25) securing PLC mounting assembly (2, Figure 6-25).
4) Tag and disconnect wires from control module (Figure 7-2) being replaced.

NOTE

When replacing PLC control (I/O) modules, ensure modules are firmly seated in chassis and retaining clip is engaged.

5) Depress retaining clip on top and bottom of control module and pull module straight out of front of chassis.
6) Install replacement PLC control (I/O) modules by reversing steps above.

b) To replace PLC power supply 24VDC input module perform steps a, b, and c under Paragraph 6.7.1 and proceed as follows:

NOTE

In order to replace PLC power supply 24VDC input module (10, Figure 6-25), 7-slot card rack chassis must be removed from PLC electrical panel assembly (8, Figure 6-24).

1) Follow steps 1 through 3 under a above.
2) Tag and disconnect wires from all control modules (Figure 7-2).
3) Depress top and bottom retaining clips and pull all control modules straight out of front of chassis.
4) Carefully disconnect wires from bottom of chassis by disconnecting tie wraps securing wire bundles.
5) Using 1/8" Allen wrench remove four bolts (8, Figure 6-25) and washers (9, Figure 6-25) securing card chassis to PLC electrical panel assembly (8, Figure 6-24) and remove card chassis.
6) Install replacement PLC power supply 24VDC input module (10, Figure 6-25) by reversing steps above.

6-7.1.3 Transformer, Fuse and Terminal Block Replacement. (Refer to Figure 6-25 unless indicated otherwise.)

a) To replace transformer (6) perform steps a, b, and c under Paragraph 6.7.1 and proceed as follows:

1) Perform steps 1 and 2 under a in Paragraph 6-7.1.2.1.
2) Tag and disconnect wiring from transformer (6).
3) Remove four screws (4) and four lockwashers (5).
4) Install replacement transformer. Change A 6-67 steps above.

b) To replace fuse block (11) proceed as follows:

1) Perform steps 1 and 2 under a in Paragraph 6-7.1.2.1.
2) Tag and disconnect wiring from fuse block.
3) Using fuse extraction tool, remove fuse (7) from fuse block (11).
4) Remove two bolts (12) and two washers (13) securing fuse block (11). Remove fuse block.
5) Install replacement fuse block (11) and fuse (7) by reversing steps above.

c) To remove terminal block (14) proceed as follows:

1) Perform steps 1 and 2 under a in Paragraph 6-7.1.2.1
2) Tag and disconnect wiring from terminal block (14).
3) Remove four bolts (12) and four washers (13) securing terminal block (14). Remove terminal block.
4) Install replacement terminal block (14) by reversing steps above.

6-7.1.4 Electrical Connector/Mounting Flange Replacement. (Refer to Figure 6-24 unless otherwise indicated.)

a) To replace electrical connectors (28, 29, 30, 31 and 32) proceed as follows:

1) Perform steps 1 and 2 under a in Paragraph 6-7.1.2.1.
2) Disconnect appropriate cable from side of PLC enclosure.
3) Tag and disconnect wiring from electrical connector (28, 29, 30, 31 or 32) being replaced.
4) Remove four bolts (23 or 26), four washers (22 or 27) and four nuts (20 or 25).
5) Remove mounting flange (21 or 24), electrical connector (28, 29, 30, 31 or 32) and gasket (33 or 34).
6) Install replacement electrical connector (28, 29, 30, 31 or 32) by reversing steps above.

b) To remove J6 Ethernet cable assembly proceed as follows:

1) Perform steps 1 and 2 under a in Paragraph 6-7.1.2.1.
2) Disconnect J6 Ethernet cable assembly (36) from the last module on the controller assembly chassis-S6 Basic Module for RS-232 Emulation (8, Figure 7-2).
3) Remove four bolts (26) and four washers (27) and remove J6 Ethernet cable assembly (36), mounting flange (37) and connector cap and chain (38).

NOTE

When re-installing connector cap and chain, ensure connector on the end of the chain is positioned under washer(27).

4) Reverse steps above to install J6 Ethernet cable assembly (36) and connector cap and chain (38).

6-7.2 Replacement of High Voltage Enclosure (HVE) Components. (Refer to Figure 6-26 unless otherwise indicated.)

WARNING

Voltages dangerous to life exist when equipment is open and energized. Do not work alone.

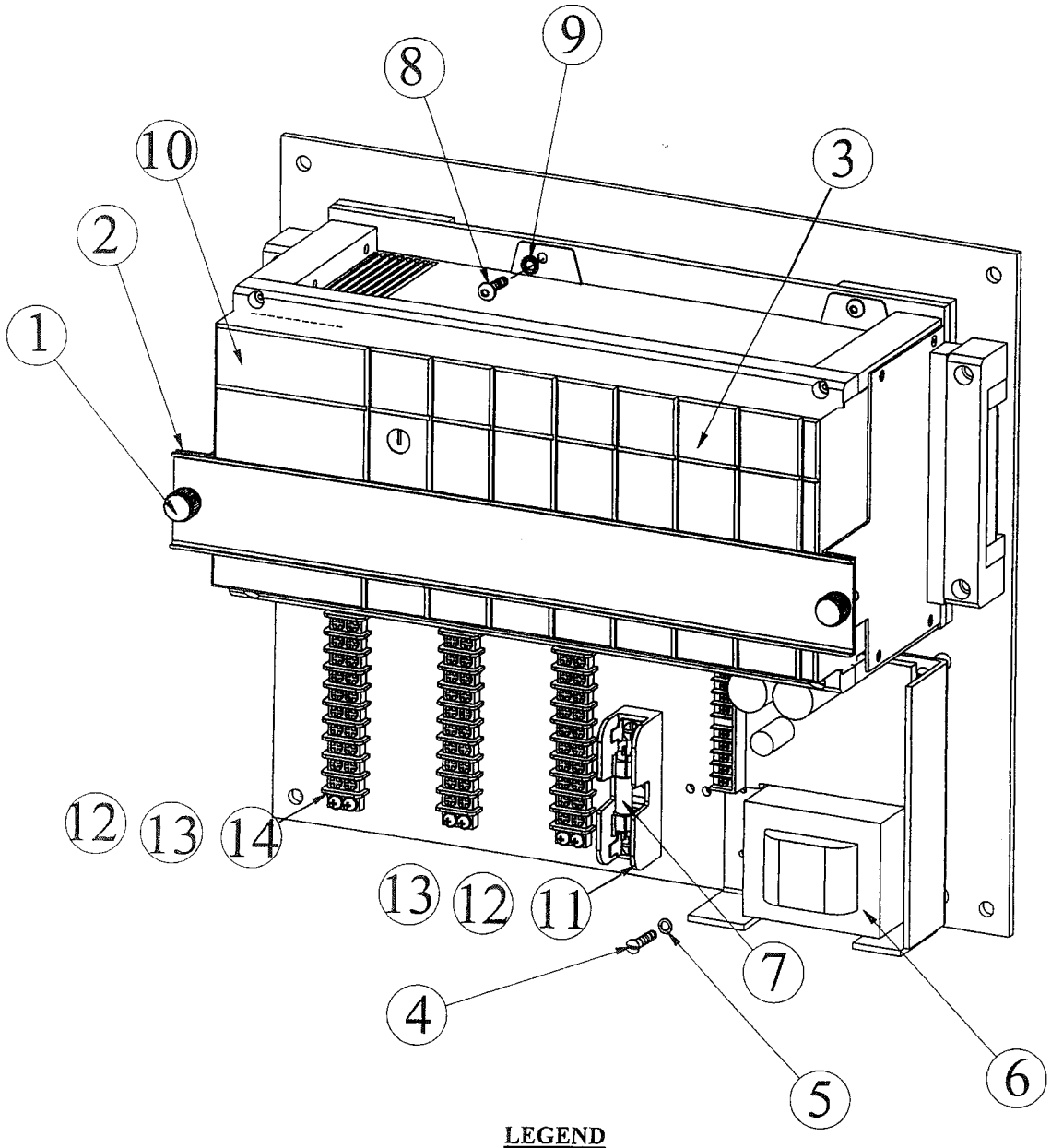
CAUTION

Always put controller in manual mode prior to turning OFF power. The controller remembers the mode of operation prior to power loss and will place controller in that mode when power is restored. This can allow uncontrolled LPAC start-up upon power restoration.

NOTE

Disassemble electrical enclosure only to point necessary to replace defective part or complete desired inspection. Reassemble from that point by reversing the steps already taken.

a) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**.
b) Turn OFF and lockout main power source to LPAC. Install OUT-OF-SERVICE tag.



LEGEND

1. MOUNTING ASSEMBLY SCREW
2. PLC MOUNTING ASSEMBLY
3. CONTROL MODULE
4. BOLT
5. WASHER
6. POWER SUPPLY TRANSFORMER
7. FUSE
8. BOLT
9. WASHER
10. PLC POWER SUPPLY 24VDC INPUT MODULE
11. FUSE BLOCK
12. BOLT
13. WASHER
14. TERMINAL BLOCK

Figure 6-25. PLC Controller Assembly

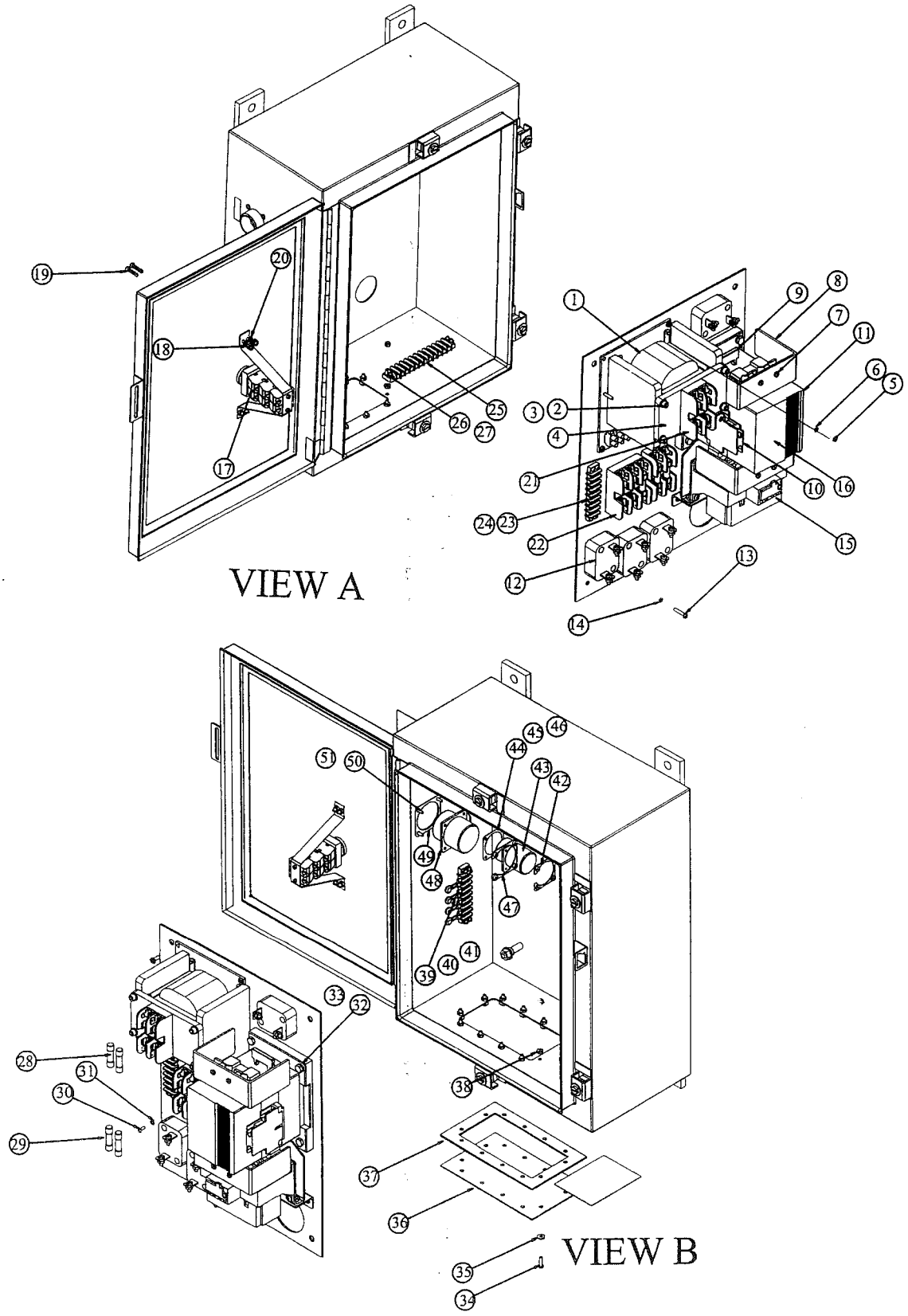


Figure 6-26. High Voltage Electrical Enclosure (HVE) (sheet 1 of 2)

LEGEND

1. POWER CONDITIONER TRANSFORMER
2. BOLT
3. LOCKWASHER
4. TRANSFORMER SUPPORT ASSEMBLY
5. NUT
6. STARWASHER
7. SCREW
8. TERMINAL COVER
9. FILTER VARISTOR
10. AUXILIARY CONTACTOR
11. AUXILIARY CONTACTOR
12. ELECTRICAL ARRESTOR
13. BOLT
14. LOCKWASHER
15. OVERLOAD RELAY
16. MOTOR CONTACTOR
17. BATTLE OVERRIDE SWITCH
18. NUT
19. BOLT
20. WASHER
21. FUSE BLOCK
22. FUSE BLOCK
23. TERMINAL BLOCK
24. BOLT
25. TERMINAL BLOCK
26. BOLT
27. NUT
28. 10 AMP 500V FUSE
29. 3 AMP 500V FUSE
30. BOLT
31. WASHER
32. BOLT
33. WASHER
34. BOLT
35. WASHER
36. PLATE COVER STUFFING
37. STUFFING GASKET (EMI)
38. NUT
39. VARISTOR INSULATED
40. BOLT
41. NUT
42. MOUNTING FLANGE
43. ELECTRICAL CONNECTOR
44. GASKET
45. BOLT
46. WASHER
47. MOUNTING FLANGE
48. ELECTRICAL CONNECTOR
49. GASKET
50. BOLT
51. WASHER

Figure 6-26. High Voltage Enclosure (HVE) (sheet 2 of 2)

c) Set ON/OFF selector switch (9, Figure 6-24) to OFF.
d) Open HVE door by pushing in and up or in and up or out on door fasteners.

6-7.2.1 HVE Electrical Component Replacement. (Refer to Figure 6-26 unless otherwise indicated.)

a) Perform steps a through d under Paragraph 6-7.2 before replacing any HVE electrical component.

6-7.2.1.1 Power Conditioner Transformer Replacement. (Refer to Figure 6-26 unless otherwise indicated.)

a) To replace power conditioner transformer (1) proceed as follows:
   1) Tag and remove wires from transformer (1).
   2) Remove four bolts (2) and lockwashers (3) from transformer support assembly (4).
   3) Remove transformer support assembly (4), four nuts (5) and star washers (6) securing transformer.
   4) Reverse steps above to install replacement transformer (1).

6-7.2.1.2 Filter Varistor Replacement. (Refer to Figure 6-26 unless otherwise indicated.)

a) To replace filter varistor (9) proceed as follows:
   1) Remove two screws (7) securing terminal cover (8).
   2) Tag and disconnect wiring at filter varistor (9).
   3) Loosen retaining screws and install replacement filter varistor (9) by reversing steps above.

6-7.2.1.3 Motor Contactor Replacement. (Refer to Figure 6-26 unless otherwise indicated.)

a) To replace motor contactor (16) proceed as follows:
   1) Remove four screws (7) securing both terminal covers (8) and remove terminal covers (8).
   2) Tag and remove wiring from motor contactor (16).
   3) Using nut driver, remove three bolts securing overload relay (15) contactors to contactors on motor contactor (16).
   4) Using 10mm nut driver remove 10mm bolt securing overload relay (15) to motor contactor (16).
   5) Remove mounting bolts (32) and washers (33) and lift motor contactor (16) out of unit.
   6) Install replacement motor contactor (16) by reversing steps above.

6-7.2.1.4 Electrical Arrestor Replacement. (Refer to Figure 6-26 unless otherwise indicated.)

a) To replace electrical arrestors (12) proceed as follows:
   1) Tag and disconnect wiring to electrical arrestor (12) being replaced.
   2) Remove two bolts (13) and two lockwashers (14) and remove electrical arrestor.
   3) Install replacement electrical arrestor by reversing steps above.

6-7.2.1.5 Overload Relay Replacement. (Refer to Figure 6-26 unless otherwise indicated.)

a) To replace overload relay (15) proceed as follows:
   1) Tag and disconnect wiring to relay (15).
   2) Using flat-blade screwdriver, remove two screws (7) securing terminal cover (8) to the left of the overload relay (15). Remove terminal cover (8).
   3) Using nut driver, remove three bolts securing overload relay (15) to motor contactor (16).
   4) Using 10mm nut driver, remove 10mm bolt securing overload relay (15). Remove overload relay (15).
   5) Install replacement overload relay by reversing steps above.

6-7.2.1.6 Battle Override Switch Replacement. (Refer to Figure 6-26 unless otherwise indicated.)

a) To replace battle override switch (16) proceed as follows:
   1) Remove locking attachment (6, Figure 6-27) from battle override switch on front of HVE door.
   2) Tag and disconnect wiring to battle override switch (16).
   3) From front of HVE door unscrew round silver bezel securing battle override selector switch (4, Figure 6-27).
   4) Remove four nuts (17), four bolts (18) and four washers (19).
   5) Loosen mounting latch (7, Figure 6-27) and lift battle override switch off of HVE door.
   6) To replace any or all of six contact blocks (5, Figure 6-27) loosen and remove two socket head bolts (1, Figure 6-27), freeing contact blocks (5, Figure 6-27).

NOTE

When replacing battle override selector switch, ensure white marking

on selector is aligned with OFF on the legend plate (3, Figure 6-27) and that selector clicks from OFF to ON.

7) Install replacement battle override switch (16) by reversing steps above.

b) Close electrical enclosure front panel and secure fasteners.

c) Restore main power source for LPAC and remove OUT-OF-SERVICE tag.

6-7.2.2 Fuse and Terminal Block Replacement. (Refer to Figure 6-26 unless otherwise indicated.)

a) Perform steps a through d under Paragraph 6-7.2.
b) To replace fuse blocks (21 and 22) proceed as follows:

1) Tag and disconnect wiring from fuse block.
2) Using fuse extraction tool, remove fuse (28 and 29) from fuse block (21 and 22).
3) Remove two bolts (30) and two washers (31) securing fuse block (21 and 22). Remove fuse block.
4) Install replacement fuse block (21 and 22) and fuse (28 and 29) by reversing steps above.
5) Perform steps b and c under Paragraph 6-7.2.1.6.

c) To replace terminal blocks (23 and 25) proceed as follows:

1) Perform steps a through d under Paragraph 6-7.2.
2) Tag and disconnect wiring from terminal block (23 and 25).
3) Remove four bolts (24 or 26) and four nuts (27) securing terminal block (23 or 25). Remove terminal block.
4) Install replacement terminal block (23 and 25) by reversing steps above.
5) Perform steps b and c under Paragraph 6-7.2.1.6.

6-7.2.3 Electrical Connector/Mounting Flange Replacement. (Index numbers refer to Figure 6-26 unless otherwise indicated.)

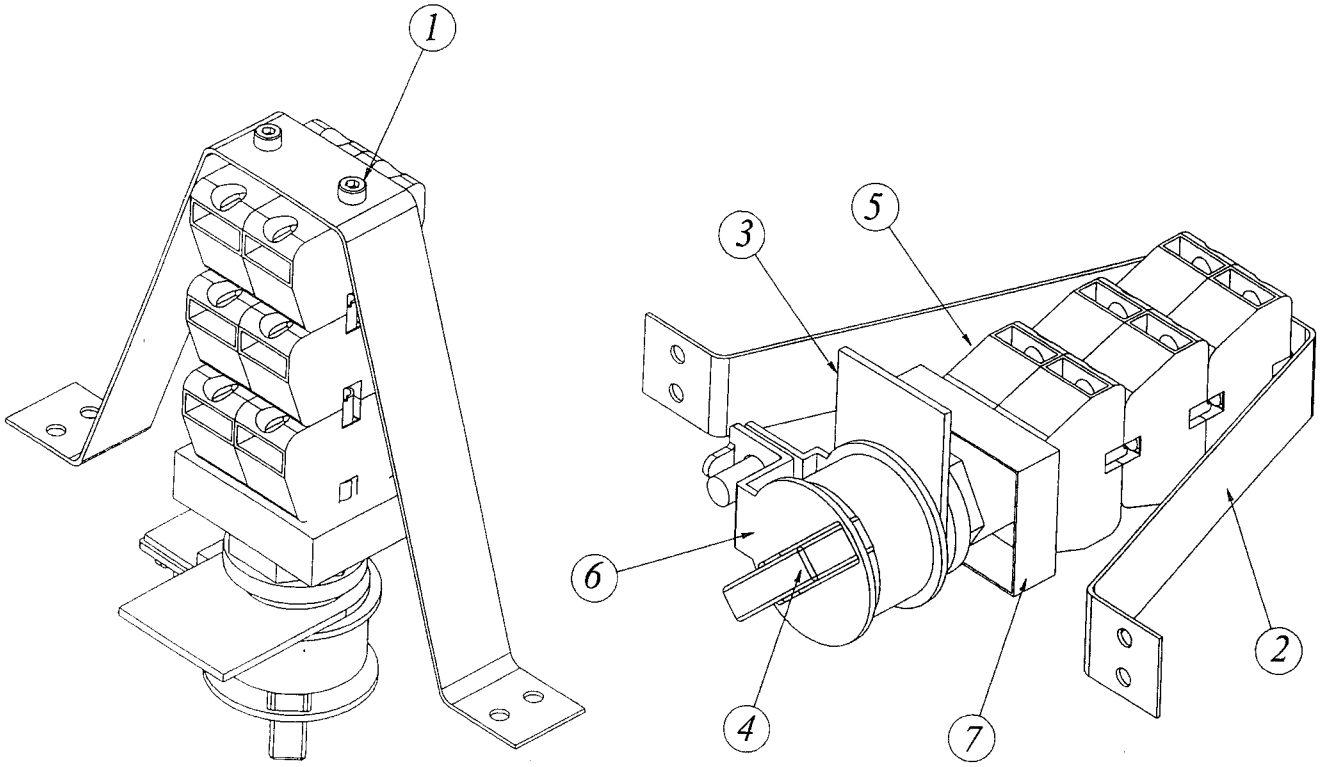
a) To replace electrical connectors (43 and 48) proceed as follows:

1) Perform steps a through d under Paragraph 6-7.2.
2) Disconnect appropriate cable from underneath of HVE.
3) Tag and disconnect wiring from electrical connector (43 and 48) being replaced.
4) Remove four bolts (45 or 50) and four washers (46 or 51).
5) Remove mounting flange (42 or 47), electrical connector (43 or 48) and gasket (44 or 49).
6) Install replacement electrical connector (43 or 48) by reversing steps above.
7) Perform steps b and c under Paragraph 6-7.2.1.6.

6-7.2.4 Plate Cover Replacement. (Refer to Figure 6-26 unless otherwise indicated.)

a) To replace plate cover stuffing (36) proceed as follows:

1) Perform steps a through d under Paragraph 6-7.2.
2) Remove twelve bolts (34) twelve washers (35) and twelve nuts (38). Remove plate cover stuffing (36) and stuffing gasket (37).
3) Install replacement plate cover stuffing (36) and stuffing gasket (37) by reversing steps above.
4) Perform steps b and c under Paragraph 6-7.2.1.6.



LEGEND

1. SOCKET HEAD BOLT
2. BATTLE OVERRIDE BRACKET
3. LEGEND PLATE
4. BATTLE OVERRIDE SELECTOR SWITCH
5. CONTACT BLOCK
6. LOCKING ATTACHMENT
7. MOUNTING LATCH

Figure 6-27. Battle Override Switch

CHAPTER 7
PARTS LIST

7-1 INTRODUCTION

This chapter provides complete parts ordering information and a replacement parts list for the model STAR 200 low pressure air compressor (LPAC). All shipboard and shore based repair parts, including attaching hardware, are listed. Assemblies considered non-repairable will not have their piece parts listed. To assist in identification, each listed part is referenced to an illustration, which depicts the part's locations. Within the parts list, major assemblies group items.

7-2. LIST OF MAJOR UNITS

Table 7-1 lists the major units of the model STAR 200 LPAC. It also references the unit's location within the parts list. Information contained in Table 7-1 is as follows:

a) **Column 1, CID, RIC, or Unit Number**. This column lists the unit number for each major unit. CID and RIC numbers are listed if available.

b) **Column 2, Quantity (QTY).** Lists the quantity of major units which make-up one model STAR 200 LPAC unit.

c) **Column 3, Name or Nomenclature.** This column contains the name or nomenclature of the major unit.

d) **Column 4, Page.** Lists the first page number of the parts list that contains unit parts.

7-3. LIST OF MANUFACTURERS

Table 7-2 is the list of manufacturers providing LPAC parts. The manufacturer's Federal Supply Code (FSCM) is also included when one has been assigned. Government handbooks H4-1 and H4-2 can be consulted for the vendor's address if an FSCM has been assigned. Where a FSCM has not been assigned, the vendor's address is listed in Table 7-2.

7-4. PARTS LIST

7-4.1 General. Table 7-3 is a parts list for the LPAC. Parts are grouped together by major unit. Within each group the parts are listed in figure and index number order. Information contained in Table 7-3 is as follows:

a) **Figure and Index Number Column.** This column contains the figure and index number where the listed part can be found.

b) **Name and Description Column**. This column contains the name and a description of the listed part. Modifiers are added to identify common parts.

c) **Quantity Column.** This column contains the quantity of the listed part per assembly.

d) **FSCM Column.** This column identifies the FSCM of the part manufacturer.

e) **Part Number Column.** This column contains the manufacturer's or Government part number for the listed part. The part number column may be blank, indicating that the part has no applicable number, but is identified for procurement by the data in the description column. A COML (Commercial entry) indicates the part or material is available through a variety of commercial sources or vendors.

7-4.2 Special Tools. The special tools required to overhaul and maintain the LPAC are listed at the end of Table 7-3 and in Chapter 6, Paragraph 6-1.4.

Table 7-1. List of Major Units

Table 7-2. List of Manufacturers

FSCM	MANUFACTURERS	ADDRESS
1DG36	E. M. Products	5380 Cottonwood Ln. Prior LK, MN 55372
2W733	Belden	P.O. Box 1980-T Richmond, IN 47375
01276	Aeroquip	3000 Strayer P. O. Box 631 Maumee, OH 43537
03024	Ketema	790 Greenfield Dr. P. O. Box 666 El Cajon, CA 92021
03743	Appleton	7770 Frontage Rd. Skokie, IL 6077
04034	Gems Company	1 Cowles Rd. Plainville, CT 06062
04813	Dixon	386 Metacom Ave. Bristol, RI 02809-5152
04845	ASCO	460 Greenway Ind. Dr. Suite J Fortmill, SC 29715 8117
10989	MECTRON Industries	6301 49th St. N. Pinellas Park, FL 34665-5798
12623	Whitey	318 Bishop Rd. Cleveland, OH 44143-1533
12665	Clark-Reliance	16633 Foltz Industrial Pkwy. Strongsville, OH 44136
20019	Tech Systems, Corp.	401 Watertown Rd. Thomaston, CT 06787-1922
21746	Versa Corporation	28 N. Clark St. P. O. Box 152 Mount Sterling, OH 43143
27192	Eaton Corp-/Cutler Hammer	5 Parkway Center Pittsburgh, PA 15220
27520	Control Products	1513 W. Jefferson St. P.O. Box 531109 Grand Prarie, TX
28953	RIX Industries	4900 Industrial Way Benicia, CA 94510
28968	Hoke	405 Centura Ct. P.O. Box 4866 Spartansburg, SC 29305
30780	Parker-Hannifin	3885 Gateway Blvd. Colombus, OH 43228-9698
32857	Consler Corporation	300 W. Main St. Honeoye Falls, NY 14472-1108
32874	Black, Sivalls & Bryson	7455 E. 46th St. Tulsa, OK 74145
34345	Kulite Semiconductors	1 Willow Tree Rd. Leona, NJ 07605-2210
34494	Kunkle	8222 Bluffton Rd. Box 1740 Fort Wayne, IN 46801
49400	Central Plastic Co.	309 E. Main St. Palmyra, PA 17078
51814	Smalley	385 Gilman Ave. Wheeling, IL 60090-5807
52676	SKF	1111 Adams Ave. Norristown, PA 19403
53790	Stauff	21-23 Industrial Pk. Waldwick, NJ 07463
54716	Technical Products & Precision Mfg. Co.	100 Log Canoe Cir. Stevensville, MD 21666
59747	Thomas (REXNORD)	304 Main Ave. P.O. Box 549 Warren, PA 16365-2157
64467	Weksler Instrument Corp.	990 S. Rogers Cir. Suite 10 Boca Raton, FL 33487
64525	Tranter	1900 Old Burk Hwy. Wichita, TX 76306
65079	DANCO	15230 Lakewood Blvd. Bellflower, CA 90706
65464	Nadir	31795 Groesbeck Hwy. P.O. Box Fraser, MI 48026-2548
79067	APCO	1420 S. Wright Blvd. Schaumberg, IL 60193
79136	Waldes Kohinoor, Inc.	500 Memorial Dr. P.O. Box 6723 Somerset, NJ 08875-6723
79568	Whittet-Higgins Co.	33 Higginson Ave. Central Falls, RI 02863-0008
80201	Forsheda (CR Services)	900 N. State St. Elgin, IL 60123-3293
80756	Spirolox	29 Cassens Ct. Fenton, MO 63026-2542
81590	Korry Electronics Co.	901 Dexter Ave. N. Seattle, WA 98109-3536
82156	ESNA	Newsburgh Rd. Hackettstown, NJ 07840
82227	North America Philips Control Corp.	150 Knotter Dr. Cheshire, CT 06410
87373	Parker	30240 Lakeland Blvd. Wickliffe, OH 44092-1747
93358	Murray Benjamin	Jericho, NY 11753
96906	Military Standards	

Table 7-2. List of Manufacturers (continued)

FSCM	MANUFACTURERS	ADDRESS
96948	Kepner Products	995 N. Ellsworth Ave. P.O. Box 310 Villa Park, IL 60181-1107
	ARMTEC	Manchester, NH 03103
06383	Panduit	17301 Ridgeland Ave. Tinkley Park, IL 60477
79926	SSP	8250 Boyle Pkwy. Twinsburg, OH 44087-2200

Table 7-3. LPAC Parts List

Figure and Index Number	Name and Description	Qty.	FSCM	Part Number
1-2	Skid	1	28953	33-ASKD1002
	Gauge, Temp., Disc. Air (28953 p/n 33-ATHR1001)	2	64467	E3-24-04 (Less Thermowell)
2-1	Compressor Management System	1	28953	
(1)	Programmable Logic Controller	1	28953	A76-D3501
(2)	High Voltage Enclosure	1	28953	A76-D305
(3)	PLC Touchscreen Display	1	28953	76-5834
(4)	Switch, Selector, Man/Auto	1	28953	A76-4535
(5)	Switch, Selector, Control Power, ON/OFF	1	28953	A76-4534
(6)	Switch, Pushbutton, Start	1	28953	A76-4536
(7)	Switch, Pushbutton, Stop/Reset	1	28953	A76-4537
(8)	Indicator, Light, Power	1	28953	A76-4538
(9)	Light, Warning Failure	1	28953	A76-4539
(10)	Switch, Battle Override	1	28953	A76-4470
(11)	Meter, Elapsed Time	1	82227	K19783-HO
2-2	Miscellaneous Controls and Indicators			
(1)	Air Pressure Drop Pop-Up Indicator			
(2)	High Pressure Relief Valve	1	28953	33-AVAL1040-1
(3)	Discharge Air Temperature Gauge	1	28953	33-ATHR1001
(4)	Gauge Panel	1	28953	33-APNL1002
(5)	Injection Water Pressure Gauge Valve	1	28953	33-310100E
(6)	Injection Water Pressure Gauge	1	28953	33-346312JC2
(7)	Discharge Air Pressure Gauge Valve	1	28953	33-310100E
(8)	Discharge Air Pressure Gauge	1	28953	33-346312JC2
(9)	Shipboard Air Pressure Gauge Valve	1	28953	33-310100E
(10)	Shipboard Air Pressure Gauge	1	28953	33-346312JC2
(11)	Make-Up and Drain Valve Manifold Block	1	28953	33-ABLK1007
(12)	Separator Fill Valve	1	28953	33-AVAL1037
(13)	Filter Drain Valve	1	28953	33-AVAL1037
(14)	Cooler and Filter Fill Valve	1	28953	33-AVAL1037
(15)	Separator Drain Valve	1	28953	33-AVAL1037
(16)	Liquid Level Sight Glass	1	28953	33-B6136
(17)	Reference			

Table 7-3. LPAC Parts List (continued)

Figure and Index Number		Name and Description	Qty.	FSCM	Part Number
2-2cont.	(18)	Cooler Seawater Pressure Gauge	1	28953	33-346312JC3
	(19)	Cooler Seawater Pressure Gauge Valve	1	28953	33-310100E
	(20)	Cooler Seawater Pressure Gauge Selector Valve	1	28953	33-AVAL1039
	(21)	Bracket, Air Filter/Seawater Gauge Panel	1	28953	33-ABRK1051A
	(22)	Capscrew, .500-13UNC x 1" Lg.	2		COML
	(23)	Nut, Regular, Hex .500-13UNC	2		COML
	(24)	Differential Pressure Gauge	1	28953	33-60-C1202-1
6-1		Pressure Gauge Panel/Pressure Transducer			
	(1)	Gauge Stem Connector (Obsolete)			
	(2)	Gauge Mounting Screw 3/8-16, 1" Lg, SS	6		COML
	(3)	Gauge Panel	1	28953	33-APNL1002
	(4)	Gauge Cover Screw	3		M14-453
	(5)	Gauge Cover	3		G13-171-01
	(6)	(Deleted)			
	(6B)	Pressure Transducer	3	34345	IPTE-311-1000-150A
	(7)	(Deleted)			
	(8)	(Deleted)			
	(9)	(Deleted)			
	(10)	(Deleted)			
	(11)	(Deleted)			
	(12)	(Deleted)			
	(13)	(Deleted)			
	(14)	(Deleted)			
	(15)	(Deleted)			
	(16)	(Deleted)			
	(17)	Transducer Mounting Plate	1	28953	38-B7044
	(17)	Single Transducer Adapter Plate	3	28953	38-A8652
	(18)	Capscrew, Hex Head 3/8-16UNC-2A, x l" Lg., A449, QQ-Z-325 Type 1 Class 3 to ASA 18.1 Zinc	2		COML
	(19)	Washer, Locking 3/8, Stainless Heli Spring	6		COML
	(20)	Capscrew, Socket Head #10-24, 1/2" Lg., SS	6		COML
	(21)	Washer, Flat SAE #10 Stainless Steel	6		COML
6-3		High Pressure Relief Valve	1	28953	33-AVAL1040-1
	(1)	Hood	1	65079	D48-12-03
	(2)	Pressure Screw	1	65079	D48-12-18-1
	(3)	Locknut	1	65079	D48-12-18-2
	(4)	Spring Plate	2	65079	D48-12-17
	(5)	Spring	1	65079	S48-12-04

Refer to Figure 6-1 comment.

Table 7-3. LPAC Parts List (continued)

Figure and Index Number	Name and Description	Qty.	FSCM	Part Number
6-3 cont. (6)	Bonnet	1	65079	D48-12-02
(7)	Snap Ring (Part of Stem, Item 28)	1		
(8)	Union Nut	1	65079	B3418-1
(9)	Tailpiece	1	65079	B3419-1
(10)	Elbow	1	28953	54F-5107-200
(11)	O-Ring, VITON	1	65079	AS568-129
(12)	Retainer Ring	1	65079	D118316R
(13)	Seat Ring	1	65079	QR4011
(14)	O-Ring (28953 P/N 33-R023-5)	1	96906	M83248/1-910
(15)	Retainer Ring	1	28953	31-B6026
(16)	Tailpiece	1	28953	554-B6027
(17)	O-Ring (28953 P/N 33-228303U9)	1	96906	M83248/1-910
(18)	Union Nut	1	65079	B3418-5
(19)	Base	1	65079	D48-8-08
(20)	O-Ring	1	65079	AS568-020
(21)	Set Screw	1	65079	D48-12-21
(22)	Gasket	1	65079	D48-12-21-2
(23)	Adjusting Ring	1	65079	D48-12-20
(24)	Disc	1	65079	D48-12-09
(24)	Disc	1	65079	DL-48-12-09
(25)	Guide	1	65079	DL48-12-15
(26)	O-Ring	1	65079	AS568-029
(27)	Body	1	65079	D48-12-01
(28)	Stem Assembly	1	65079	D48-12-16
(29)	Gasket	1	65079	D48-12-04
6-4	LPAC Rear View			
(1)	Seal Vent Line	1	28953	33-AHSE1014
(2)	Relief Valve	1	28953	33-ADSC1001
(3)	Unloader Valve Air Line	1	28953	33-AHSE1014
(4)	Flexible Hose	1	28953	33-AHSE1013
(5)	Stud, 3/4-10UNC-3A X 3-1/2" Lg, Full Rolled Thd, A193-B7, Zinc PL., To QQ-Z-325, Type I CL.3	8		COML
(6)	Suction Unloader Valve Assembly	1	28953	33-AUNL1001A
(6A)	Mounting Nuts (Reference)			
(7)	Distance Piece Side Cover	1	28953	33-B6298-1
(7A)	Mounting Nuts (Reference)			
(7B)	Distance Piece Filter Cover	1	28953	33-B6298-2
(8)	Drive Coupling	1	28953	33-ACPL1016A
(9)	Drive Motor	1	28953	33-AMTR1001
(10)	Compressor Assembly	1	28953	33-ACOM1001A

Table 7-3. LPAC Parts List (continued)

Figure and Index Number	Name and Description	Qty.	FSCM	Part Number
6-4 cont. (11)	Filter Hold-Down Straps	1	28953	33-ABRK1051A
(12)	Pressure Drop Indicator	1	60342	RBX00-2277
(12)	Elbow, Male	1	28953	4-CBU-SS
(13)	Air Inlet Filter Assembly (28953 P/N 33-AFLRC018)	1	1DG36	FRU04-X0278
(14)	Nut, 3/4-10UNC, Steel UNS No. G1080, Zinc PL., to QQ-Z-325, Type I, CL.3	8		COML
(15)	Mounting Nuts (Reference)			
(16)	Distance Piece	1	28953	33-ADTP100A
(17)	Drive Motor Base (Reference)			
(18)	Injection Water Line	1	28953	33-AHSE1012
(19)	Nut, 3/4-10UNC, Steel UNS No. G1080, Zinc PL., to QQ-Z-325, Type I, CL.3	8		COML
(20)	Water Filter Assembly	1	28953	33-AFLR1002A
(21)	Heat Exchanger Assembly	1	64525	UX-056-UJ-31-SPEC
(22)	Wiring Harness, Motor to Electrical Enclosure	1	28953	33-AHAR1001
(23)	Support Bracket	1	28953	33-ABRK1041A
(24)	Spacer	4	28953	33-ASPC1023
(25)	Bushing, Electrical	1	28953	33-ABSH1020
(26)	Fitting, 45 deg. Conduit (P/N 33-AFTG1020)	1	3743	St-45125
(27)	Fitting, Myers Hub, 1-1/4" Pipe Size (P/N 33-AFTG1020)	1		COML
(28)	Bracket	1	28953	33-B6557
(29)	Stud, 5/8-11UNC-3A x 3-1/4" Lg.; A193 B7, Zinc pl.	2		COML
(30)	Nut, 5/8-11UNC; steel A194 GR.2H, Zinc pl.	4		COML
6-5	Suction Unloader Assembly			
(1)	Mounting Nuts, 3/8-16 UNC, Steel A194, GR 2H, Zinc PL., QQ-Z-325, Type I, CL. 3	6		COML
(2)	Screw, Hex Head Cap, 3/8-16 UNC-2A X 1-1/2" Lg; A449, Zinc PL., QQ-Z-325, Type I, CL.3, to ASA B 18.2	7		COML
(3)	Diaphragm Cover	1	28953	33-ACOV1030
(4)	Diaphragm	1	28953	33-ADPH1001
(5)	Valve Plunger	1	28953	33-APLG1002-1
(6)	Compression Spring	1	28953	33-ASPG1004
(7)	Compression Spring	1	28953	33-ASPG1005
(8)	Screw, Socket Head Cap, 3/8-16UNC X 1-3/4" Lg; A276 Type 304SS	1		COML
(9)	Washer, Plain, SAE STD, 3/8" Bolt Size, A276 Type 410SS	1		COML
(10)	Spring Retainer	1	28953	33-ARTR1004
(11)	Valve	1	28953	33-AVAL1004
(12)	Valve Gasket	1	28953	33-AGKT1001
(13)	Unloader Valve Shaft	1	28953	33-ASHF1005

Table 7-3. LPAC Parts List (continued)

Figure and Index Number		Name and Description	Qty.	FSCM	Part Number
6-5 cont.	(14)	Retaining Ring	1	79136	5008-100
	(15)	Valve Bearing	2	4813	5206
	(16)	Plug, Straight Thread (28953 P/N 54P-4P50NSS)	1	54716	8319-4
	(17)	O-Ring (28953 P/N 33-228303U8)	1	96906	MS3248/1-904
	(18)	Unloader Housing	1	28953	33-ABOD1002
	(19)	Stud	6	28953	33-11099942
	(20)	Gasket, unloader	1	28953	33-11178654
6-6	(1)	Air-End Check Valve Assembly (28953 P/N 33-AVAL1029)	1	79067	Mod 302.980
	(2)	Stud	4	28953	33-11099959
	(3)	Nut, 5/8-11UNC, Steel A194 GR. 2H, Zinc PL. to QQ-Z-325, Type I, CL. 3	4		COML
	(5)	Gasket, 4-1/16" O.D. X 1-3/4" I.D.	1	28953	33-AGKT1030
	(6)	Bushing	1	79067	302-5/5M
	(7)	Spring	1	79067	302-4/33
	(8)	Body	1	79067	302-1/51
	(9)	Plug	1	79067	302-3S/5M
	(10)	Seat Ring	1	79067	302-2/51
	(11)	Gasket, 4-1/16" O.D. X 2-1/4" I.D.	1	28953	33-AGKT1020
	(12)	Temperature Switch (28953 P/N 33-ASWT1002)	1	27520	M2002 "Close On Fall"
	(13)	O-Ring (28953 P/N 33-RR42M0041)	1	30780	N1000-70-905
6-7		Gate Rotor Assemblies			
	(1)	Nut, 3/8-16UNC, Steel A 194 GR 2H, Zinc PL., To QQ-Z-325, Type I, CL. 3	56		COML
	(2)	Side Cover	2	28953	33-ACOV1029
	(3)	Stud	32	28953	11099926
	(5)	Free-End Cover	2	28953	33-ACOV1027
	(7)	Gate Rotor Shaft Nut	2	82156	09NU-149Monel
	(8)	Free-End Washer	2	28953	33-AWSR1002
	(10)	Gate Rotor Shaft Assembly	2	28953	33-ASHF1002A
	(11)	Gate Rotor Shaft Assembly Shim Set	1	28953	33-ASHM1029
	(12)	O-Ring (28953 P/N 33-RR1682)	4	30780	N674-70-156
	(13)	Thrust End Washer	2	28953	33-AWSR-1003
	(14)	Thrust Washer Shim Set	1	28953	33-ASHM1030
	(15)	Stud	24	28953	33-11099934
	(16)	Gate Support Assembly	2	28953	33-ASUP1003A
	(17)	O-Ring (28953 P/N 33-RR161)	2	30780	N670-70-010
	(18)	Gate Rotor	2	28953	33-AROR1005
	(19)	Gate Retaining Ring	2	28953	33-ARNG1010
	(20)	Gate Wave Spring	2	51814	SSR-0287-S17
	(21)	Gate Snap Ring	2	80756	RST250S

Add " with bolted thrust washers.".

Table 7-3. LPAC Parts List (continued)

Figure and Index Number		Name and Description	Qty	FSCM	Part Number
6-7 cont.	(22)	Locating Pin	2	28953	33-A7959
	(23)	Gate Rotor Locating Bolt	2	28953	33-APIN1004
	(24)	Pipe Plug (Countersink), 1/4" NPT, A276 Type 316SS	4		COML
	(25)	Fitting, Plug (28953 P/N 54P-4P5ONSS)	2		547168319-4
	(26)	O-Ring (28953 P/N 33-228303U8)	2	96906	MS3248/1-904
	(27)	Pipe Plug (Countersink), 1" NPT, A276 Type 316SS	2		COML
	(28)	Gasket, Free-End Cover	2	28953	33-11157526
	(29)	Gasket, Side Cover	2	28953	33-11157518
	(30)	O-Ring (28953 P/N 33-228303U9)	1	96906	MS83248/1-910
	(31)	Plug (28953 P/N 54P-10P5ONSS)	1	54716	8319-10
	(32)	O-Ring (28953 P/N 123-912-5)	3	96906	MS3248/1-912
	(33)	Fitting, Plug (28953 P/N 54P-12HPSONSS)	3	87373	12HPSONSS
		Gate Rotor Assemblies (with Bolted Thrust Washer)			
	(34)	Plastic Window	2	28953	33-B6341
	(35)	Window Frame	2	28953	33-B6341-1
	(36)	Gate Rotor Shaft Assembly	2	28953	A33-ASHF2000
	(37)	Thrust End Washer	1	28953	20-B6918
	(38)	Thrust Washer Shim Set	1	28953	A33-B6920
	(39)	Bolt, Socket Head, 5/16-18UNC x 2" Lg., Stainless	6		COML
	(40)	Washer, AN, 5/16" size, Stainless	6		COML
6-8		Drive Coupling Assembly	1	28953	33-ACPL1016A
	(1)	Hex-Head Capscrew, Metric 8mm x 1.25mm, Pitch x 20mm Lg., GR8 Steel	16		COML
	(2)	Bushing	2	52676	SHT 1-7/8
	(2A)	Threaded Ring (Part Of Bushing)	2		
	(3)	Hub	2	59747	C047914
	(4)	Nut	8	59747	C16506
	(5)	Short Bolt	8	59747	B010634
	(6)	Links	8	59747	11874
	(7)	Short Bevel Washer	8	59747	B010690
	(8)	Disk Pack	2	59747	B010689
	(9)	Center Ring			
	(10)	Nut			
	(11)	Long Bolt (Part Center Ring)	4		
	(12)	Not Used			
	(13)	Long Bevel Washer	8		

Delete.

Include the CAGE code and P/N for index item 13.

Include index item 14 as found on Figure 6-8.

Table 7-3. LPAC Parts List (continued)

Figure and Index Number	Name and Description	Qty	FSCM	Part Number
6-9	Drive Motor (28953 p/n 33-AMTR1001)	1	20019	5KS326NS129H
(1)	Screw, ¼-20 x ¾" Lg, Hex Head	4	96906	MS90725-6
(2)	Lockwasher, 1/4	4	96906	MS35338-44
(3)	Cover, Terminal Box	1	20019	149C4433AB1
(4)	Gasket, Cover	1	20019	235A4560AR1
(5)	Screw, #10-32 x 3/8" Lg, Pan Head	8	96906	MS35207-261
(6)	Lockwasher #10	8	96906	MS35338-43
(7)	End Shield	1		
(8)	Baffle	2	20019	192B6705-23
(9)	Screw, 3/8"-16 X 1" Lg, Hex Head	4	96906	MS50725-60
(10)	Washer, External Tooth, 3/8	4	96906	MS35335-21
(11)	Bearing Cap	1	20019	153B2347AB1
(12)	Not Used			
(13)	Bearing, Ball (28953 P/N 33-ABRG 1050)	1	20019	K55-0077
(14)	Screw, ½-13 x 1 ¼" Lg, Hex Head	8	96906	MS16998-96
(15)	Lockwasher, 1/2	8	96906	MS3338-48
(16)	End Shield	1	20019	128D6364TS1
(17)	Rotor	1	20019	32RA101270AM01
(18)	Baffle	1	20019	192B6705-23
(20)	Lockwasher, 5/16	4	96906	MS35338-48
(21)	Bearing Cap	1	20019	153B2347AA1
(22)	Gasket	1	20019	235A4560TS3
(23)	Bearing, Ball (28953 P/N 33-ABRG 1060)	1	20019	K55-0048
(24)	Spring Washer	1	20019	K92-0010
(25)	Stator	1	20019	32WC101270G016
(26)	Frame	1	20019	128D7351AC1
(27)	Screw, 5/16 X 3-1/4" Lg, Pan Head	4	96906	MS90725-45
(28)	Lockwasher, 5/16	4	96906	MS35338-48
(29)	Terminal Box	1	20019	149C4432AE2
(30)	Gasket, Saddle	1	20019	235A4560N1
(31)	Plug, 1/8-27	1	96906	MS20913-1
(32)	Plug, 3/8-18	1	96906	MS20913-3
(33)	Plug, 1/8-27	1		MS20913-1
(34)	Plug, 3/8-18	1		MS20913-3
(35)	Hex Nut			
(36)	Spring Washer			

Provide the missing data.

Table 7-3. LPAC Parts List (continued)

Figure and Index Number	Name and Description	Qty	FSCM	Part Number
6-10	Main Rotor Assembly			
(1)	Nut, 5/8-11NC, Steel A194 GR 2H, Zinc PL., To QQ-Z-325, Type I, CL., 3	16		COML
(2)	Drive-End Bearing Retainer	1	29853	33-ARTR1002
(3)	Lip Seal	1	28953	33-ASEL1001
(4)	Main Rotor	1	28953	33-AROR1001A
(5)	Housing, Compressor Assembly	1	28953	33-AHSG1005
(6)	Nut, 3/8-16UNC, Steel A 194 GR 2H, Zinc PL., QQ-Z-325, Type I, CL., 3	8		COML
(7)	Suction-End Bearing Carrier	1	28953	33-ACRR1006
(8)	O-Ring (28953 P/N 33-RR1112)	4	30780	N674-70-166
(9)	O-Ring	2	30780	N674-70-125
(10)	Stud	16	28953	33-11099967 COML
(11)	Screw, Socket-Head Cap, Nylon Pellet Center, 15/64" From Tip, ½-13UNC X 1 ¼" Lg, A276 TP 304SS	1		COML
(12)	Suction-End Bearing Retainer	1	28953	33-ARTR1003
(13)	Shaft Sleeve	1	28953	33-ABRG1003
(14)	Locknut	1	79568	BHSS-12
(15)	O-Ring (28953 P/N 33-RR1822)	1	30780	N674-70-168
(16)	Ball Bearing, Drive-End (Matched Set)	1	28953	33-ABRG1007
(17)	(Not Used)			
(18)	V-Ring Seal (2853 P/N 33-ASEL1003-1)	2	80201	CR400754
(19)	Seal Cup	1	28953	Delete. L1002
(20)	O-Ring (28953 P/N 123-043-5)	1	30780	V747-75-043
(21)	Drive-End Bearing Carrier	1	28953	33-ACRR1003
(22)	Snap Ring	1	80756	VR400
(23)	Retaining Ring	1	28953	33-ARNG-1013
(24)	O-Ring (P/N 28953 P/N 33-RR1682)	1	30780	N674-70-154
(25)	Labyrinth Seal	1	28953	33-ASEL-1004
(26)	Plug	1	54716	8319-6
(27)	Carbon Bushing	1	28953	33-ABRG1004
(28)	Snap Ring	2	80756	RRT356S
(29)	Drive-End Shims	1	28953	33-ASHM1031
(30)	O-Ring (28953 P/N 33-RR1682)	1	30780	N674-70-156 COML
(31)	Stud, 3/8-16UNC-3A X 1-3/4" Lg, Full, Rolled Thd. A193 B7, Zinc PL., QQ-Z-325, Type I, CL. 3	8		COML
(32)	O-Ring (28953 P/N 123-906-5)	1	96906	MS83248/1-906
(33)	Retainer	2	28953	33-A8078
(34)	Dowel Pin, 3/8" diameter (28953 P/N 17-17)	4	39428	98381A624

Table 7-3. LPAC Parts List (continued)

Figure and Index Number	Name and Description	Qty	FSCM	Part Number
6-11	Rotor Concentricity Test Set-Up			
(1)	Shaft Tool	1	28953	33-AROR1001A
6-12	Check Valve, Potable Water (28953 P/N 33-AVAL1035)	1	96948	908B-1
(1)	Cap	1	96948	1000B-101
(2)	Seal	1	96948	3000-168
(3)	Retainer	1	96948	3000B-102
(4)	Poppet	1	96948	3000B-103
(5)	Spring	1	96948	1000-104
(6)	Body	2	96948	3000B-100
6-13	Check Valve, Injection Water Loop (28953 P/N 33-AVAL1030-1)	1	96948	1724B-3
(1)	Cap	1	96948	3072B-101
(2)	Seal (28953 P/N 33-ORNG1000)	1	7618	3071-114
(3)	Retainer	1	7618	3071B-102
(4)	Poppet	1	96906	3071B-103
(5)	Spring	1	96906	1124-104
(6)	Body	1	96906	3214B-100
6-14	Selector Valve			
(1)	Gauge Valve Assembly (28953 P/N 33-310100E)	4	54716	6GN282-1-CT
6-15	Gauge Valve			
(1)	Lanyard	1	54716	8340.CA
(2)	Cap Nut	1	54716	5230.CD
(3)	Handle	1	54716	6402.DK
(4)	Locknut, Panel	1	54716	5231-2.AA
(5)	Lockwasher	1	54716	6707.CA
(6)	Nut, Bonnet	1	54716	8307-8.CY
(7)	Union Nut	2	54716	7850-4.CY
(8)	Union Tailpiece	2	54716	7849-4.AD
(9)	O-Ring	2	54716	4564-008-EU
(10)	Body	1	54716	6261.CV
(11)	O-Ring	1	54716	4564-010.EU
(12)	Back-Up Ring	1	54716	6342-010.EL
(13)	Stem	1	54716	6263.CF
(14)	Bonnet	1	54716	6262.CL
(15)	Spline Key	2	54716	6540.BA
(16)	Locknut, Handle	1	54716	5231-1.AA

Table 7-3. LPAC Parts List (continued)

Figure and Index Number	Name and Description	Qty	FSCM	Part Number
6-15 cont. (17)	Cap	1	54716	6464.CF
(18)	Sleeve, Stop	1	54716	STI-S.DM
6-16	Water Filter Assembly	1	28953	33-AFLR1002A
(1)	Nut, .5-13UNC, Zinc PL,. SA-194-2H	16		COML
(2)	Filter Cover Flange	1	28953	33-AFLG1009
(3)	Special Tools (Ref. Fig. 7-11, Fig. 7-12, and Par. 6-1.4)	1	28953	33-G707940669Z
(4) & (5)	Element Cover Assembly	1	28953	33-ACOV1038A
(6)	Filter Element (28953 P/N 33-AELM1001)	1	32857	15470N5
(7)	Stud, .5-13UNC x 3" Lg., SA-193 GR B7, Zinc PL.	8		COML
(8)	Filter Housing Assembly	1	28953	33-AFLR1004A
(9)	Nut, 5/8-11UNC, Steel UNS No. G1080, Zinc PL., to QQ-Z-325, Type I, CL. 3	8		COML
(11)	Stud, 5/8-11UNC-3A x 1/4" Lg., Full Rolled Thd, A193-B7, Zinc PL., to QQ-ZZ-325, Type, I CL. 3	4		COML
(12)	Plug, .56-18UN-2B, SS	1	96906	MS16142
6-17	Make-Up and Drain Solenoid Valve Assemblies (28953 P/N 33-AVAL1033)	2	4845	JVA228-048-1-120VAC
	Onboard rebuild kit (contains figure 6-19, index nos. 3, 7-8, 12, 14, & 17-20)	AR	4845	
6-18	Blowdown Solenoid Valve (28953 P/N 33-AVAL1032)	1	4845	JVA228-049-1-120VAC
	Onboard Rebuild Kit (contains figure 6-19, index nos. 3, 7-8, 10, 14-18, & 21-24)	AR	4845	310594
6-19	Shut-Off Injection Solenoid Valve Assembly (28953 P/N 33-AVAL1031)	1	4845	HSX8210D22MO
	Onboard repair kit (contains figure 6-20, index nos. 3, 7-9, 14-16, 19-22, 24, 26 ar	AR	4845	312838
6-20	Separator Assembly	1	28953	33-ASEP1001A
(1)	Nut, 1/2-13UNC, Steel UNS No. G1030 Zinc PL., to QQ-Z-325, Type I, CL. 3	12		COML
(2)	Stud, 1/2-12UNC-3A x 3-3/4" Lg., Full Rolled Thd, A 193-B7, Zinc Pl., to	6		COML
(3)	Water level Switch Assembly	1	28953	33-ASWT1001
(4)	Gasket	1	28953	33-AGKT1012-1
(5)	Nut, 5/8-11UNC, Zinc PL., SA-194-2H	32		COML
(6)	Gasket	1	28953	33-G717751612Z
(7)	Top Cover Assembly	1	28953	ASEP1002A
(7A)	Cap Screw, Hex Head, 7/16-14UNC x 1-3/4" Lg., Plated Steel	16		COML

Change the descriptions to match Figure 6-16 legend.

General comment. Change the descriptions to match Figure 6-20 legend.

General comment. Change the descriptions to match Figure 6-20 legend.

Table 7-3. LPAC Parts List (continued)

Figure and Index Number	Name and Description	Qty	FSCM	Part Number
6-20 cont. (7B)	Level Gauge	1	28953	33-B6136
(8)	Sight Glass, (28953 P/N 33-AGLS 1000)	1	12665	9G81-41
(9)	Gasket, Liquid Level Sight Glass (28953 P/N 33-AGKT1040)	2	12665	9G9660
(10)	Stud, 5/8-11UNC x 4 ¾" Lg., SA 193 GR B7, Zinc PL.	16		COML
(12)	Housing	1	28953	33-ASEP1003A
(13)	O-Ring	1	54716	N674-70-912
(14)	Plug (28953 P/N 54P-4P50NSS)	2	54716	8319-4
(15)	O-Ring	2	54716	N674-70-904
(16)	Fill Hoses (Reference)			
(17)	Stud, 5/8-11UNC x 3-1/4" Lg., SA 193 GR B7, Zinc PL.	8		COML
(18)	Nut, 5/8-11UNC, Zinc PL., SA-194-2H	8		COML
6-21	Heat Exchanger Assembly	1	64525	UX-056-UJ-31 SPEC
(1)	Nozzle, 2", Titanium	2	96906	SK-F-89060
(2)	Nozzle, 2", TP-316L. Stainless	1	96906	SK-F-89060
(3)	Nut, 3/4-10UNC, Steel UNS No. G1080, Zinc PL., to QQ-Z-325, Type I, CL. 3	8		COML
(3A)	Locknut, Thin Hgt., 3/4-10UNC, All Steel, Zinc Plated			
(4) & (5)	Shroud Stud Assembly	4	96906	SK-F-89060-19 SK-F-89059-19 SK-F-89059-20
(6)	Shroud, 5-5/16	1	96906	SK-F-89063
(7)	Stop Bolt	1	96906	SK-F-89059-15; 19
(8)	Bolt Assembly, 10-3/4" Lg., 1" Dia.	4	96906	SK-F-89062-98
(9)	Moveable Frame Assembly	1	96906	SK-F-98061
(12)	Insulator, 1/8" Thk x 1/2" Wide	2	96906	SK-F-89063
(13)	B-1234 Plate Assembly	14	64525	7.82124E+11
(14)	E-0000 Plate Assembly	1	96906	SK-F-89039
(15)	A-1234 Plate Assembly	15	64525	7.82124E+11
(16)	D-1234 Plate Assembly	1	64525	8.22124E+11
(17)	Stationary Frame Assembly	1	96906	SK-F-89060
(18)	Stop Gauge, 1" x 7-15/16"	4	96906	SK-F-89062
(19)	Removable Base Plate	2	96906	SK-F-89061-1
(20)	A/B Gasket	29	64525	2019650005
(21)	D Gasket	1	64525	8.2202E+11
(22)	Stud, 3/4-10 UNC-2A x 1/2" Lg., Steel, GR. 5, Zinc PL.	4		COML
(23)	Washer, 3/4" , Steel , Zinc PL.	4		COML
(24)	Sleeve, .84" O.D. x .76" I.D. x 1-9/16" Lg., Nylon 11 C-40 (28953 P/N 33-ASLV1100)	4	49400	210-0003 3/4" x 1-9/16"

Add item number 25 to include the "isolator block" as found in the figure legend.

Table 7-3. LPAC Parts List (continued)

Figure and Index Number	Name and Description	Qty	FSCM	Part Number
6-22	Pneumatic Pilot Valve	1	21746	VPS-2502-S-167-2131
	Valve Repair Kit	AR	21746	V4532
6-23	Ball Valve			
(1)	Nut	1	12623	SS-6NJ-0256
(2)	Washer, Spring	1	12623	SS-13B-63
(3)	Nameplate			
(4)	Stop Plate	1	12623	304-51C63-2
(5)	Handle	1	12623	SS-51K-63-BK
(6)	Spring	1	12623	302-13-63
(7)	Nut	1	12623	SS-6NJ-0397
(8)	Washer, Spring	1	12623	SS-13B-63
(9)	Washer, Spring	1	12623	SS-13B-63
(10)	Gland	1	12623	SS-8A-63
(11)	Support, Packing	1	12623	PK-8C-63
(12)	Packing, Top	1	12623	TYT-9A-63
(13)	Packing, Bottom	1	12623	TYT-9B-63
(14)	Nuts	1	12623	304-61K-63
(15)	Flange	1	12623	B1B-63XXX
(16)	O-ring	1	12623	VA70-9-121
(17)	Spring	1	12623	SS-9S-3T
(18)	Seat	1	12623	SS-9S-63T
(19)	Ring, Support	1	12623	SS-9C-63
(20)	Bolts	4	12623	S-61K-63
6-24	Programmable Logic Controller	1	28953	A76-D3051
(1)	Control Panel Assembly	1	28953	A38-D3117
(2)	Bolt, Button Head	46	28953	32-1188
(3)	Washers	46	28953	20-4029
(4)	Control Panel Gasket	1	28953	16-B7253
(5)	Display Cable (Part of Touchscreen Display P/N 76-5834)	1		
(6)	Front Cover	1	28953	38-D3109
(7)	Front Cover Gasket	1	28953	16-B7254
(8)	PLC Electrical Panel Assembly	1	28953	A158-D3101
(9)	ON/OFF Selector Switch	1	28953	A76-4534
(10)	MAN/AUTO Selector Switch	1	28953	A76-4535
(11)	START Pushbutton Switch	1	28953	A76-4536
(12)	STOP/RESET Pushbutton Switch	1	28953	A76-4537
(13)	MOTOR RUNNING Indicator Light	1	28953	A76-4538
(14)	WARN/FAIL Indicator Light	1	28953	A76-4539
(15)	Hours Meter	1	28953	113-703
(16)	Bolt, Pan Head, #4-40 x ½" L., SS	1	28953	32-4412

Add index items 21-30 to include missed items as found in the figure legend. Refer to Equipment manual S6220-EE-MMA-010, Table 7-3, Figure 6-24.

Table 7-3. LPAC Parts List (continued)

Figure and Index Number	Name and Description	Qty	FSCM	Part Number
6-24 cont. (17)	Hours Meter Mounting Bracket	1	28953	40-A8775
(18)	Display Cover	1	28953	A14-B7648
(19)	PLC Touchscreen Display	1	28953	76-5834
(20)	Nut	12	28953	COML
(21)	Mounting Flange 28, 4 x 6-32	4	28953	53-30255
(22)	Washer, Locking, #6-SS	16	28953	20-1004
(23)	Bolt, Round Head, #6-32 x 5/8" L., SS	16	28953	32-6769
(24)	Mounting Flange, 22A-4 x 4-40	1	28953	53-30254
(25)	Nut			COML
(26)	Bolt, Pan Head, #4-40 x ½" L., SS	8	28953	32-4412
(27)	Washer, Locking, #4 SS	8	28953	20-4406
(28)	Electrical Connector	1	28953	61-1050
(29)	Electrical Connector	1	28953	61-1049
(30)	Electrical Connector	1	28953	61-1048
(31)	Electrical Connector	1	28953	61-1047
(32)	Electrical Connector	1	28953	61-1046
(33)	Gasket, 28	4	28953	16-30258
(34)	Gasket, 22A	1	28953	16-30257
(35)	Gasket, 16S	1	28953	16-30256
(36)	J6 Ethernet Cable Assembly	1	28953	A61-B8022
(37)	Mounting Flange 16A	1	28953	53-30253
(38)	Connector Cap and Chain	1	28953	138-5412
(39)	Access Cover	1	28953	33-B7613
(40)	Access Cover Gasket	1	28953	16-B7624
(41)	120VAC Bulb	2	28953	
6-25	PLC Controller Assembly			
(1)	Screw, Mounting Assembly (Part of PLC Mounting Assy)			
(2)	Mounting Assembly, PLC	1	28953	A40-D3100
(3)	Control Module			Refer to Fig. 7-2
(4)	Bolt, Pan Head, #8-32, 7/8" L., SS	4	28953	32-4455
(5)	Washer, Flat, SAE, #10 SS	4	28953	20-4029
(6)	Power Supply Transformer	1	28953	A185-B7830
(7)	Fuse, 2 Amp	1	28953	163-49
(8)	Bolt, Button Head, #10-24, 3/8"L., SS	4	28953	32-6372
(9)	Washer, Flat, SAE, #10, SS	4	28953	20-4029
(10)	PLC Power Supply 24VDC Input Module	1		Refer to Fig. 7-2
(11)	Fuse Block	1	28953	163-31
(12)	Bolt, Round Head, #6-32, 5/8"L., SS	14	28953	32-1182
(13)	Washer, Star, #6, SS	14	28953	20-4404
(14)	Terminal Block (12 Terminals)	3	28953	138-512

Table 7-3. LPAC Parts List (continued)

Figure and Index Number	Name and Description	Qty	FSCM	Part Number
6-26	HVE	1	28953	A76-D3052
(1)	Transformer, Power Conditioner, Model CX250P	1	28953	185—B8144
(2)	Bolt, Hex Head ¼-20, 1" L., SS	4	28953	32-1138
(3)	Washer, Locking, ¼ , SS	4	28953	20-407
(4)	Transformer Support Assembly	1	28953	A40-B7421
(5)	Nut, Hex #10-32 Stainless	4	28953	53-4409
(6)	Washer, Locking, #10, SS	4	28953	20-4037
(7)	Screw (Part of Terminal Cover Kit)	4		
(8)	Terminal Cover Kit	2	28953	76-4479
(9)	Filter Varistor	1	28953	76-1320
(10)	Auxiliary Contactor-1NO & 1NC	1	28953	76-4477
(11)	Auxiliary Contactor-2NO	1	28953	76-4478
(12)	Electrical Arrestor	4	28953	167-409
(13)	Bolt, Pan Head, #8-32, 7/8" L., SS	8	28953	32-4455
(14)	Washer, Locking, #8, SS	8	28953	20-4042
(15)	Overload, Relay SMP-2 Type	1	28953	76-4491
(16)	Motor Contactor	1	28953	76-4476
(17)	Battle Override Switch Assembly	1	28953	A76-4470
(18)	Nut, Hex, #6-32, Nylok, SS	4	28953	53-30393
(19)	Bolt, Round Head, #6-32, ½"L., SS	4	28953	32-1168
(20)	Washer, Flat, SAE, #6, SS	8	28953	20-6375
(21)	Fuse Block, Double, 600V	1	28953	163-37
(22)	Fuse Block, Triple, 600V	1	28953	163-58
(23)	Terminal Block, 12 Terminals	2	28953	138-416-1
(24)	Bolt, Round Head, #6-32, 5/8"L., SS	12	28953	32-30395
(25)	Terminal Block, 12 Terminals	1	28953	138-512
(26)	Bolt, Round Head, #6-32, 5/8"L., SS	12	28953	32-30395
(27)	Nut, Hex, #6-32, Nylok, SS	12	28953	53-303-93
(28)	Fuse, 10Amp, 500V	2	28953	163-53
(29)	Fuse, 3Amp, 500V	5	28953	163-56
(30)	Bolt, Pan Head, #6-32, 3/8"L., SS	6	28953	32-4413
(31)	Washer, Star, Locking, #6, SS	6	28953	20-4404
(32)	Bolt, Hex Head, ¼-20, 1"L., SS	4	28953	32-1138
(33)	Washer, Locking, ¼, SS	4	28953	20-407
(34)	Bolt, Pan Head, #8-32, 5/8"L., SS	12	28953	32-4541
(35)	Washer, Flat, SAE, #8, SS	12	28953	20-4542
(36)	Plate Cover Stuffing	1	28953	38-A8722
(37)	Stuffing Gasket (EMI)	1	28953	16-4464

Table 7-3. LPAC Parts List (continued)

Figure and Index Number	Name and Description	Qty	FSCM	Part Number
6-26 cont. (38)	Nut, Hex, #8-32 SS	12	28953	53-4097
(39)	Varistor, Insulated	4	28953	A167-A8986
(40)	Bolt, Round Head, #6-32, 5/8" L., SS	12	28953	32-30395
(41)	Nut, Hex, #6-32, Nylok, SS	12	28953	53-30393
(42)	Mounting Flange, 22A-4 x 4-40	2	28953	53-30254
(43)	Electrical Connector	1	28953	61-1053
(44)	Gasket , 22	2	28953	16-30257
(45)	Bolt, Pan Head, #4-40, ½"L., SS	8	28953	32-4412
(46)	Washer, Flat, SAE, #4 SS	8	28953	20-4405
(47)	Mounting Flange 28, 4 x 6-32	1	28953	53-30255
(48)	Electrical Connector	1	28953	61-1002
(49)	Gasket, 28	1	28953	16-30258
(50)	Bolt, Round Head, #6-32, ½"L., SS	8	28953	32-1168
(51)	Washer, Flat, SAE, #6, SS	8	28953	20-6375
6-27	Battle Override Switch Assembly	1	28953	A76-4470
(1)	Bolt, Socket Head, M3, 6mm L.	2	28953	32-5475
(2)	Bracket, Battle Override	1	28953	40-A8762
(3)	Legend Plate, Battle Override	1	28953	62-4474
(4)	Switch, Selector, 2-Position, Battle Override	1	28953	76-4470
(5)	Contact Block, Switch Part, 1 N.O. Cont	6	28953	76-4472
(6)	Switch Part, Battle Override, Locking Attachment	1	28953	76-4473
(7)	Switch Part, Battle Override, Mounting Latch, 2 Across	1	28953	77-4471
7-1	Main Rotor Shaft Assembly	1		
(2)	Main Rotor	1		33-ASHF1004
(3)	Main Rotor Shaft Assembly	1		33-AROR1001A
(4)	Screw, Socket Head Cap, 3/8-16 UNC x 1" Lg., A276 Tp 304SS-Cond. A	8		COML
7-2	PLC Control Modules			
(1)	PLC Power Supply (Programmed by Rix Industries)	1	28953	AB1746-P3
(2)	SLC 5/05 CPU Module (Programmed by Rix Industries)	1	28953	76-A8710-11
(3)	Digital Input Module (Programmed by Rix Industries)	1	28953	76-A8710-3
(4)	Analog Input Module (Programmed by Rix Industries)	1	28953	76-A8710-4
(5)	Input Module (Programmed by Rix Industries)	1	28953	76-A8710-5
(6)	Output Module (Programmed by Rix Industries)	2	28953	76-A8710-6
(7)	S6 Basic Module for RS-232 Emulation (Programmed by Rix Industries)	1	28953	76-A8710-7

Table 7-3. LPAC Parts List (continued)

Figure and Index Number	Name and Description	Qty	FSCM	Part Number
7-3	(Not Used)			
7-4	Distance Piece Assembly	1	28953	33-ADTP1001A
(2)	Distance Piece	1	28953	33-ADTP1003
(3)	Distance Piece Cover (solid)	1	28953	33-B6298-3
(4)	Stud, 5/16-18UNC-3A x 1 ¼" Lg., Full Rolled Thd; A193 B7 Zinc Pl., to QQ-Z-325, Type I, CL. 3	8		COML
(5)	Washer, Plain, 5/16" Bolt Size, A276, Type 410 SS, Condition A	8		COML
(6)	Nut, 5/16-18UNC, Steel A194 GR 2H, Zinc Pl., to QQ-Z-325, Type I, CL., 3	8		COML
(7)	Stud, 5/8-11 UNC-3A x 2 ½" Lg., Full Rolled Thd; A 193 B7, Zinc Pl., to QQ-Z-325, Type I, CL., 3	12		COML
(8)	Nut, 5/8-11UNC, Steel A 194 GR 2H, Zinc Pl., to QQ-Z-325, Type I, CL	12		COML
(9)	Stud, 3/8-16UNC-3A x 1 ¾" Lg., Full Rolled Thd; A193 B7, Zinc Pl., to QQ-Z-325, Type I, CL., 3	4		COML
(10)	Nut, 5/8-11UNC, Steel A 194 GR 2H, Zinc Pl., to QQ-Z-325, Type I, CL	4		COML
(11)	Distance Piece Cover (open) Delete.	1	28953	33-B6298-1
(12)	Filter Cover	1	28953	33-B6298-2
(13)	Filter	1	28953	77-A3846
	Distance Piece Cover	2	28953	33-ACOV1031
	NOTE: Replaces items (3), (11), (12), and (13) on units built to drawing list 6915565			
7-5	Air Inlet Filter Assembly			
(1)	Air Inlet Filter Assembly (28953 P/N 33-AFLRCO18)	1	1DG36	FRUO4-X0278
(2)	Filter Element	1	1DG36	
(3)	Indicator, Restriction	1	1DG36	
(4)	Band Assembly	1	1DG36	RMB 10-0001
(5)	Wing Nut 3/8-16UNC, 304515	1		COML
(6)	Gasket	1	28953	33-AGKT1005
7-6	Main Piping Assembly	1	28953	33-APIP1048A
(2)	Flanged Elbow (28953 P/N 33-AELL1002)	2	96906	4730-00-929-1102
(3)	Hydraulic Hose, 2.22" OD x 3" Lg. (28953 P/N 33-AHSE 1011)	1	96906	4720-00-177-1721
(4)	Adapter Elbow (28953 P/N 54P-25032424C)	1	87373	2503-24-24C
(5)	Fitting, Hose (28953 P/N 33-AFTG1003)	8	96906	4730-00-588-2597
(6)	Hydraulic Hose, 1.75" OD x 15' Lg. (28953 P/N 33-AHSE 1012)	1	96906	4720-00-423-1001
(8)	Hose Adapter (28953 P/N 54P-05032424C)	3	87373	0503-24-24C
(10)	Adapter Elbow (28953 P/N 54P-25032424C)	1	87373	2503-24-24C

Table 7-3. LPAC Parts List (continued)

Figure and Index Number		Name and Description	Qty	FSCM	Part Number
7-6 cont.	(11)	Elbow Hose Adapter	1	28953	33-AELL1005
	(13)	Flange, Hose	1	28953	54-B6970
	(14)	U-Bolt 2 28953	1	28953	33-ABLT1005
	(15)	Gasket	1	28953	16-A7577
	(17)	Hose, 7" Lg.	1	28953	33-AHSE1013
	(18)	Hose Clamp, 4" Worm Type #72, SS	2		COML
	(19)	Nut, 3/8-16UNC, Steel UNC No. G1080, Zinc Pl., to QQ-Z-325, Type I, CL. 3	4		COML
	(20)	Screw, Hex Head Cap, 5/8-11 NC x 2 ¼" Lg., Grade 5, Phosphate Coated	8		COML
	(21)	Stud, 5/8-11 UNC-3A x 3-14" Lg; Full Rolled Thd; A193 B7, Zinc PL., QQ-Z-325, Type I, CL. 3	4		COML
	(22)	Nut, 5/8-11UNC, Steel No. G1080, Zinc Pl., QQ-Z-325, Type I, CL., 3	20		COML
	(23)	Screw, Hex Head Cap, 5/8-11UNC x 4" Lg. Grade 5 Phosphate Coated	4		COML
	(24)	Isomode Pad	2	28953	33-APAD1016
	(25)	Spacer Plate	2	28953	33-APLT1081
	(26)	Isolation Plate	2	28953	33-APAD1017
	(27)	Reinforcement Plate	2	28953	33-APLT1080
	(28)	45 Degree Elbow Adapter	2	87373	3503-24-24C
	(29)	Stud, ½-13UNC-2A x 4" Lg., Monel	12	96906	MIL-S-1222
	(30)	Nut, Self Locking, ½-13UNC-3B, Monel	12	96906	MIL-S-1222
	(31)	Plug, Straight Thread (92853 P/N 54P4P50NSS)	2	87373	4-P50N-SS
	(32)	Gasket, 4-1/16 O.D. x 2-1/4 I.D.	1	28953	33-AGKT1020
	(33)	Gasket, 4-1/16 O.D. x 1-3/4 I.D.	1	28953	33-AGKT1030
	(34)	O-Ring (28953 P/N 33-228303U4)	1	96906	M83248/1-924
	(35)	F. W. Inlet Elbow	1	28953	33-APIP1110-1
	(36)	F. W. Outlet Elbow	1	28953	33-APIP1110-2
	(37)	S. W. Inlet Spool Piece	1	28953	33-APIP1108
	(38)	S. W. Outlet Spool Piece	1	28953	33-APIP1109
	(39)	Washer, ½", Monel	24		COML
	(40)	Sleeve, .56" O.D. x .51" I.D. x 13/16" Lg.,			
	(41)	Gasket, 2"-250#, Navy Flange, 1/8" Thick, Duralon 9500	2	28953	16-A7945
7-7		Drain Fill Piping Assembly			
	(1)	Adapter, Hose, Straight Thread 928953 (P/N 54P-050368C)	3	87373	0508-6-8C
	(2)	Fitting, Hose (28953 P/N 33-AFTG1004)	32	96906	4730-00-203-3558
	(3)	Hydraulic Hose, .77" O.D. x 40' Lg. (28953 P/N 33-AHSE 1014)	1	96906	4720-00-187-4279
	(4)	Fitting, Branch Tee, Straight Thread (28953 P/N 54P-253T88C)	1	87373	253T-8-8C

Table 7-3. LPAC Parts List (continued)

Figure and Index Number	Name and Description	Qty	FSCM	Part Number
7-7 cont. (6)	Fitting, Run Tee, Straight Thread (28953 P/N 54P-053T88C)	5	87373	053T-8-8C
(8)	Adapter, Hose, Straight Thread (28953 P/N 54P-050388C)	4	87373	0503-8-8C
(9)	Adapter, Hose, Male (28953 P/N 54P-050388C)	4	87373	0103-6-8C
(10)	Exhaust Silencer (28953 P/N 33-ASLR 1002)	1	65464	MFT38
(11)	Reducer, Straight Thread (28953 P/N 54P-051046C)	1	87373	0510-4-6C
(12)	Adapter, Hose, Elbow (28953 P/N 54P 250386C)	1	87373	2503-8-6C
(13)	Fitting, Hose ((28953 P/N 33-AFTG 1005)	4	96906	4730-00588-2587
(14)	Hydraulic Hose, .67" O.D. x 6' Lg., (28953 P/N 33-AHSE 1015)	1	96906	4720-00-187-4102
(15)	Adapter, Hose, Elbow (28953 P/N 54P 250386C)	1	87373	2503-8-6C
(16)	Adapter, Hose, Male (28953 P/N 54P010388C)	2	87373	0103-8-8C
(17)	Potable Water Check Valve (Ref. Fig. 6-12)	1		
(18)	Drain Manifold Block	1	28953	33-ABLK1007
(19)	Ball Valve (28953 P/N 33-AVAL1037)	3	12623	B63TMS8
(20)	Ball Valve (28953 P/N 33-AVAL1036-1)	1	12623	SS62TMS6
(25)	Adapter, Hose, Elbow (28953 P/N 54P 250366C)	3	87373	2503-6-6C
(26)	Adapter, Hose, Elbow (28953 P/N 54P 250388C)	5	87373	2503-8-8C
(27)	Manifold Block	1	28953	33-ABLK1006
(28)	Ball Valve (28953 P/N 33-AVAL1038)	2	12623	SS-91K-62T
(29)	Union, Straight Thread (28953 P/N 54P-050566C)	3	87373	0505-6-6C
(30)	Union, Straight Thread (28953 P/N 54P-050588C)	3	87373	0505-8-8C
(31)	Elbow, Swivel Nut (28953 P/N 54P-390388C)	3	87373	3903-8-8C
(32)	Screw, Hex Hd, 5/16-18 UNC-2A x 1 ¼ Lg., A449, Zinc Pl, QQ-Z-325, Type I, CL., 3, To ASA B18.2.	2		COML
(33)	Nut, 5/16-18UNC, Steel UNS No. G1080, Zinc PL., QQ-Z-325, Type I, CL. 3	2		COML
(34)	Lock Washer, Helical Spring, 5/16" Regular, A276 TP 304SS, To ASA B27.1	2		COML
(35)	Screw, Hex Head Cap, ¼-20UNC-2A x ½ Lg., A449, Zinc PL., QQ-Z-325, Type I, CL. 3, To ASA B18.2	4		COML
(36)	Solenoid Bracket	1	28953	33-ABRK1015
(37)	Screw Hex Head Cap, ¼-20UNC-2A x 1" Lg; A449, Zinc PL., QQ-Z-325, Type I, CL. 3; To ASA B18.2	8		COML
(38)	Nut, ¼-20UNC, Steel UNS No. G1080, Zinc PL., To QQ-Z-325, Type I CL. 3	2		COML
(39)	Lock Washer, Helical Spring, 1/4" Regular; AA276 type 304SS; to ASA B27.1	2		COML
(40)	Screw, Hex Head Cap, 3/8-16UNC-2A X 2-1/4" Lg; ASA, Zinc PL., QQ-Z-325, Type I, CL.3; to ASA B18.2	2		COML
(41)	Nut, 3/8-16UNC, Steel UNS No. G1080, Zinc PL., to QQ-Z-325, Type I, CL.3	2		COML
(42)	Lock Washer, Helical Spring, 3/8" Regular; A276 type 304SS; to ASA B27.1	2		COML
(43)	Screw, Hex Head Cap, 7/16-UNC-2A x 3/4" Lg; A449, Zinc PL., QQ-Z-325, Type I, CL.3; to ASA B18.1	2		COML
(44)	Lock Washer, Helical Spring, 7/16" Regular; A276 type 304SS; to ASA B27.1	2		COML

Table 7-3. LPAC Parts List (continued)

Figure and Index Number		Name and Description	Qty	FSCM	Part Number
7-7cont.	(45)	Restrictor Adapter, 0.188 Orifice	1	28953	33-AADP1014
	(46)	Restrictor Adapter, 0.250 Orifice	1	28953	33-AADP1015
	(47)	Clamp	2	87373	CL-12
	(48)	Nipple, Pipe (28953 P/N 54P-3/8FF-SS)	1	87373	3/8FF-SS
	(49)	Hose Tee Assembly (28953 P/N 33-AFTG1008)	1	87373	8S5X-SS ATEE1005
	(50)	O-Ring (28953 P/N 33-228303U7A)	13	30780	N674-70-906
	(51)	O-Ring (28953 P/N 33-228303U3A)	24	30780	N674-70-908
	(52)	Tee Assembly	1	28953	33-ATEE106A
	(53)	O-Ring (28953 P/N 33-228303U8A)	1	380780	N674-70-904
	(54)	Plug, Straight Thread (28953 P/N 54P-5P50N-SS)	1	87373	5-P50N-SS
	(55)	O-Ring (28953 P/N 33-RR42M0041)	1	30780	N1000-70-905
	(56)	Bushing	1	28953	33-A7918
	(57)	Can Assembly	1	28953	A33-CANASSY
	(58)	Tee, 37° Flare, 3/4-16 (28953 P/N33-ATEE1007)	1	1276	259-2033-8-8
	(59)	Screw, Hex Head Cap, 3/8-16UNC x 1" Lg.; A449, Zinc Plated	1		COML
	(60)	Nut, 3/8-16UNC, Steel UNS NO. G1080, Zinc Plated	1		COML
	(61)	Filter Housing Assembly	1	28953	A33-B6139
	(62)	Filter Element	1	5430	U20A4U
	(63)	Elbow, Male, 3/4-16, 37° Flare to 3/4 NPT (28953 P/N 54P-812CTXSS)	2	87373	8-12-CTX-SS
	(64)	Screw, Hex Head Cap, 3/8-16UNC x 1 1/2" Lg., A449 Zinc Plated	2		COML
	(65)	Nut, 3/8 –16UNC, Steel UNS NO. G1080, Zinc Plated	2		COML
7-8		Instrumentation Arrangement			
	(1)	Pressure Gauge (28953 P/N 33-346312JC2)	3	64467	SA23-3PHP-RWBO
	(2)	Pressure Gauge (28953 P/N 33-346312JC3)	1	64467	SA23-3PJP-RWBO
	(4)	Ball Valve (28953 P/N 33-AVAL1039)	1	12623	SS-43XMS4
	(5)	Tubing 1/4" O.D. x .35 WL. x 35' Lg.; ASTM B111, 70-30 Cu-Ni	1		COML
	(6)	Tee, 1/4", Tube Union (28953 P/N 54C-H8104SS)	5	54716	8310-4SS
	(7)	Connector, Male, 1/4" Tube to 7/16-20 Straight Thread (28953 P/N 54C-H8594SS)	4	54716	8303-4-4SS
	(8)	Elbow, Male, 1/4" Tube to 7/16-20 Straight Thread (28953 P/N 54C-H82344SS)	7	54716	8323-4-4SS
	(9)	Connector, Male, 1/4" Tube to 1/8" NPT (28953 P/N 54C-H85442SS)	1	54716	8301-4-2SS
	(11)	Elbow, Male, 1/4" Tube to 1/8" NPT (28953 P/N 4CBUSS)	1	87373	4-CBU-SS
	(16)	Double Tube Clamp			SPDS-1064/064-PP-US-AS
	(17)	Tube Clamp Assembly	1	28953	33-A7635
	(21)	Screw, Hex Head Cap, 3/8-16UNC-2A x 1" Lg.; A449,	12		COML

Table 7-3. LPAC Parts List (continued)

Figure and Index Number		Name and Description	Qty	FSCM	Part Number
7-8 cont.	(23)	Lock Washer, Helical Spring, 3/8" Regular; A276 type 304SS; to ASA B27.1	12		COML
	(24)	O-Ring (28953 P/N 33-RR171)	39	30780	N674-70-011
	(25)	O-Ring (28953 P/N 33-RR171)	11	30780	N674-70-011
	(27)	Tail Piece, Special	1	28953	33-AFTG1014
	(28)	Screw, Hex Head Cap, 5/16-18UNC-2A x 3/4" Lg., A449, Zinc PL to QQ-Z-325, type I, CL. 3	1		COML
	(29)	Nut, 5/16-18UNC, Steel UNS No. G1080, Zinc, PL., to QQ-Z-325, Type I, CL. 3	1		COML
	(30)	Tee, Male Run, 1/4" Tube to Straight Thread (28953 P/N 54C-H816444SS)	1	54716	8164-4-4-4SS
7-9	(1)	Nut, 7/8-9UNC, Steel UNS No. G1080, Zinc PL., to QQ-Z-325, Type I, CL. 3	1		COML
	(2)	Stud, 7/8-9UNC-3A x 6-1/4" Lg., Full Rolled Thd, A193-B7, Zinc PL., to QQ-Z-325, Type I, CL. 3	5		COML
	(3)	Stud, 7/8-9UNC-3A x 5-1/4" Lg., Full Rolled Thd., A193-B7, Zinc PL., to QQ-Z-325, Type I, CL. 3	1		COML
	(4)	Spacer	6	28953	33-ASPC1030
	(5)	Nut, 5/8-11UNC, Steel UNS No. G1080, Zinc Pl., to QQ-Z-325, Type I, CL. 3	1		COML
	(6)	Screw, Hex Head Cap, 5/8-11UNC-2A x 1-1/2" Lg., A449, Zinc PL., to QQ-Z-325, Type I, CL. 3			
	(7)	Support Bracket	1	28953	33-ABRK1042A
7-10		External Parts Package	1	28953	33-ACNT1045A
	(1)	Detector, Temperature (28953 P/N 33-ACNT1076)	4	ARMTEC	247-00001
	(3)	Interconnect Harness J1	1	28953	61-C2341
	(4)	Interconnect Harness J2	1	28953	61-B5650
	(5)	Electrical Harness J4	1	28953	61-C2340
	(6)	Electrical Harness J3	1	28953	61-C2342
	(7)	Electrical Harness J5	1	28953	61-C2343
	(8)	Electrical Harness H1	1	28953	61-B5648
	(9)	O-Ring (28953 P/N 33-228303U9)	4	96906	MS82324/1-910
	(15)	Packing (28953 P/N 33-ACNT1090)	4	93358	M19622/16-0005
	(17)	Terminal (28953 P/N 33-ACNT1092)	8	06383	PN14-6R-C
7-13		V-Ring Installation Tool	AR	289523	A33-B6294
7-14		Flow Meter Assembly			
	(1)	Differential Pressure Gauge	1	28953	60-C1202-1
	(2)	Mounting Bracket	1	28953	33-B6420
	(3)	Gauge Valve	2	28953	33-310100E
	(4.1)	Tubing, "High" gauge Valve to Orifice	1	28953	33-B5702-11
	(4.2)	Tubing, Gauge to Gauge Valve	2	28953	33-B5702-12
	(4.3)	Tubing, "Low" Gauge Valve to Orifice	1	28953	33-B5702-13

Table 7-3. LPAC Parts List (continued)

Figure and Index Number	Name and Description	Qty	FSCM	Part Number
7-14 cont. (5)	Male Connector, ¼" Tube to 7/16-20 STR THD; SS	2	28953	54C-H85944SS
(6)	Orifice Plate	1	28953	113-B6367
(7)	Male Elbow, ¼ Tube to 7/16-20 STR THD; SS	2	28953	54C-H82344SS
(8)	Screw, Hex Head Cap, ¼-20 UNC x ¾" Lg., Steel Zinc Plate	4		COML
(9)	Nuts, ¼-20 UNC; Steel UNS No. G1080, Zinc Pl., To QQ-Z-325, Type I CL. 3	4		COML
(10)	O-Ring, ARP #011, BUNAN	4	28953	33-RR171
(11)	O-Ring, ARP #904, BUNAN	4	28953	33-228303U8A
7-15	Filter Flange Assembly			
(1)	Filter Flange Assembly	1	28953	33-AFLG-1100
(2)	Channel	1	28953	39-B6087
(3)	Spacer Plate	1	28953	66-B6088
(4)	U-Bolt with Nuts (28953 P/N 33-ABLT1010)	1	3A054	3043T49
(5)	Screw, Hex Head Cap, 3/8-16UNC-2A x 2-1/4" Lg.; A449, Zinc Pl.	2		COML
	Special Tools (Ref. Fig. 7-11, Fig. 7-12, and Par. 6-1.4)			
(1)	(DELETED)			
(2)	(DELETED)			
(3)	Compressor Air-End Support Fixture (Ref. Fig. 7-11)		28953	33-AFIX100
(4)	Housing Indicating Fixture (Ref. Paragraph 6-1.4)	AR	28953	33-AIND1003
(5)	Lock Nut Tool (Ref. Fig. 7-12)	AR	28953	33-B5844
(6)	Main Rotor Locating Block (Ref. Fig. 6-11)	AR	28953	88-B5658
(7)	Seal/Bearing Assembly Tool (Ref. Paragraph 6-1.4)	AR	28953	33-TOOL4
(8)	Rotor Spacer Ring (Ref. Paragraph 6-1.4)	AR	28953	33-TOOL1
(9)	Bearing Ring (Ref. Paragraph 6-1.4)	AR	28953	33-TOOL2
(10)	Shaft Tool (Ref. Fig. 6-11)	AR	28953	33-B5659
(11)	Dial Indicator Mounting Plate (Ref. Fig. 6-11)	AR	28953	33-A7630
(12)	Bearing Lock Nut Torque Tool (Ref. Paragraph 6-1.4)	AR	28953	A33-B5743
(13)	Antifoam Agent (28953 P/N 33-FOAM1000)	AR	71984	Antifoam A

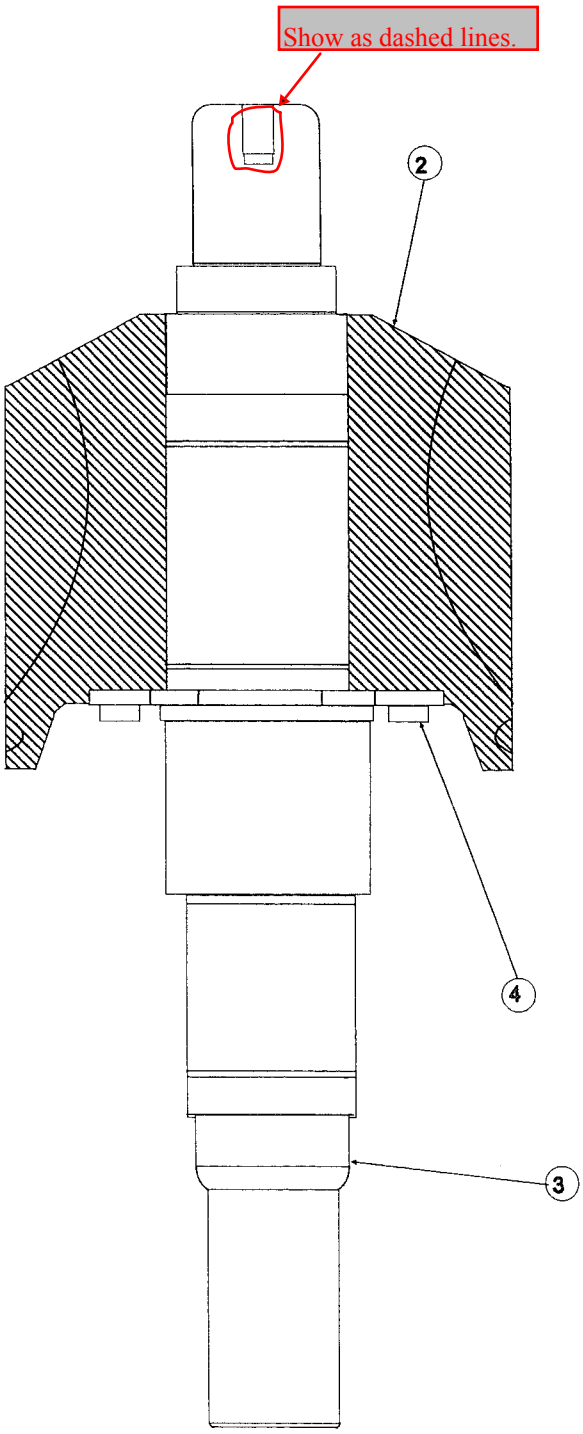


Figure 7-1. Main Rotor Shaft Assembly

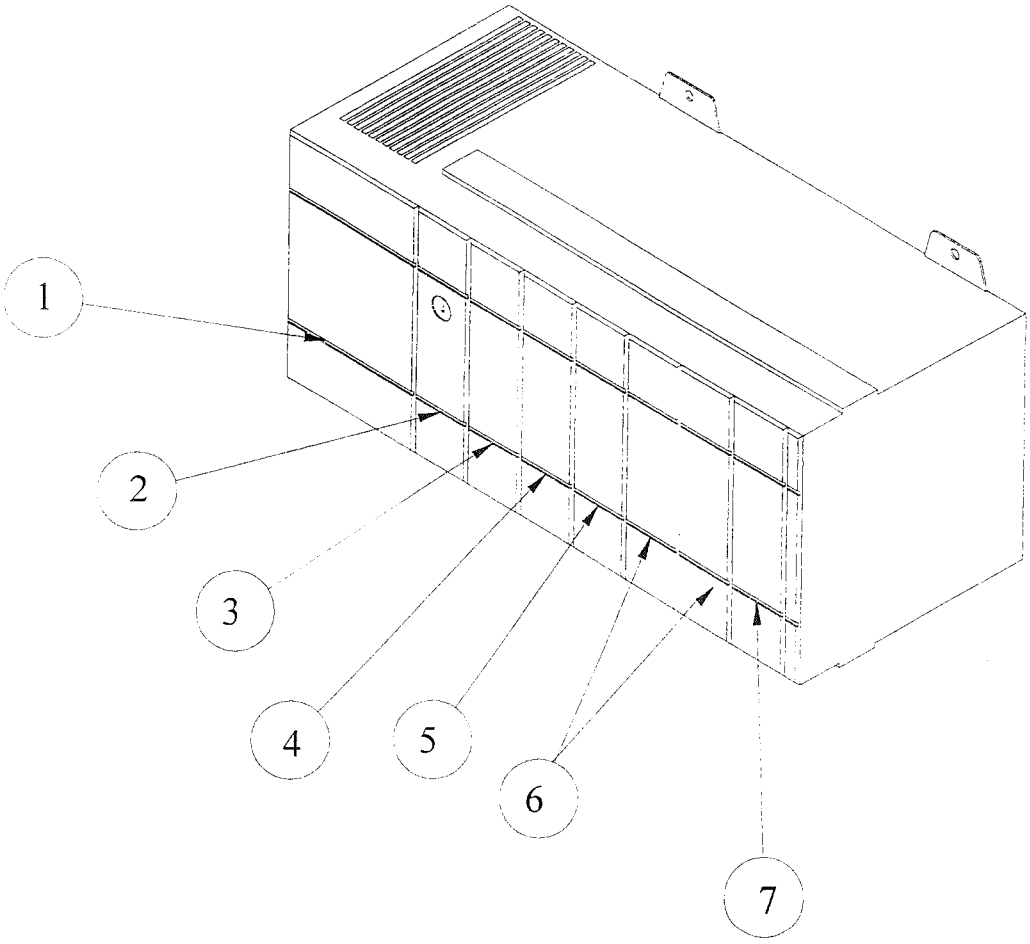


Figure 7-2. PLC Control Modules

Figure 7-3. (Not Used)

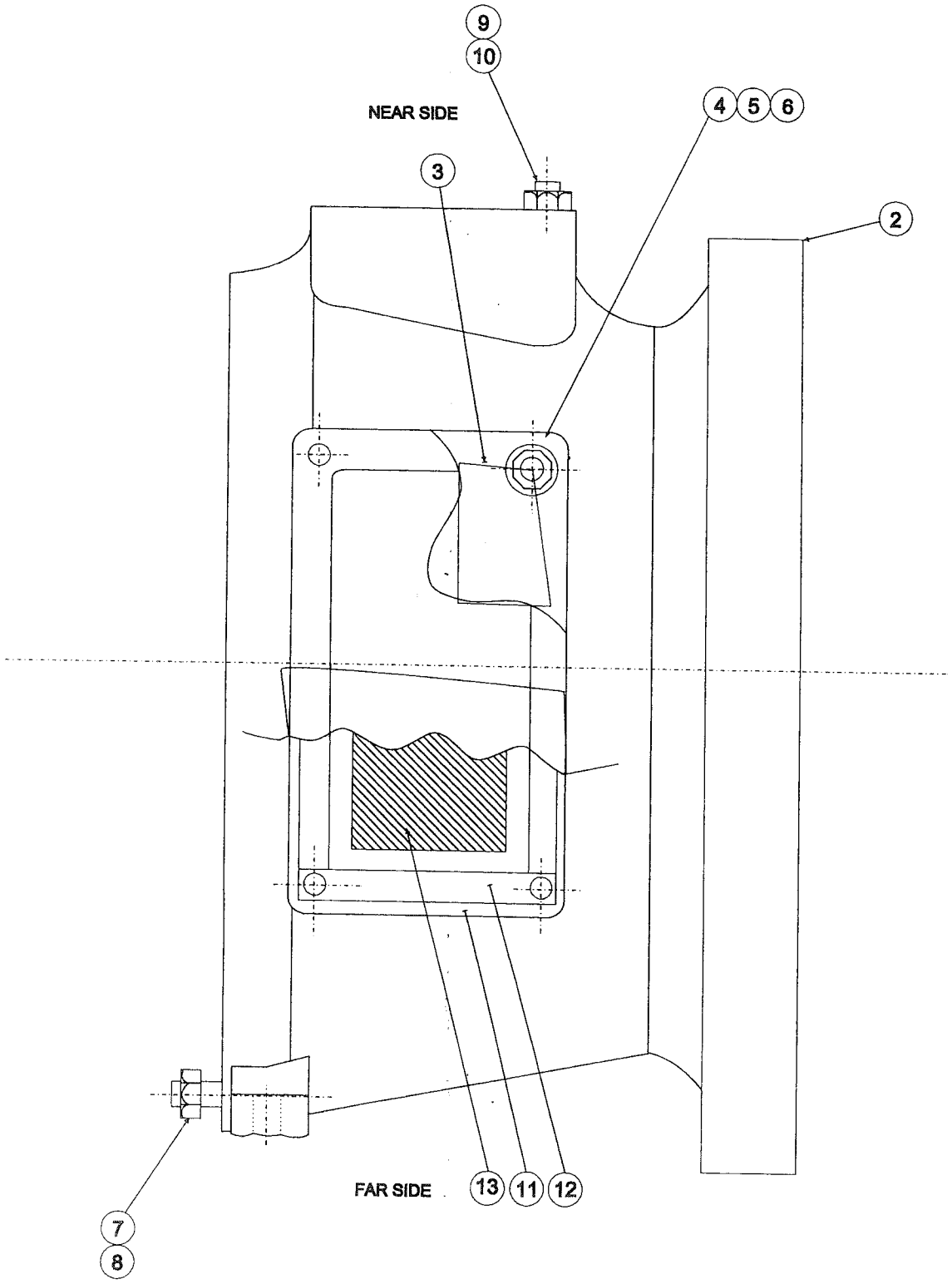


Figure 7-4. Distance Piece

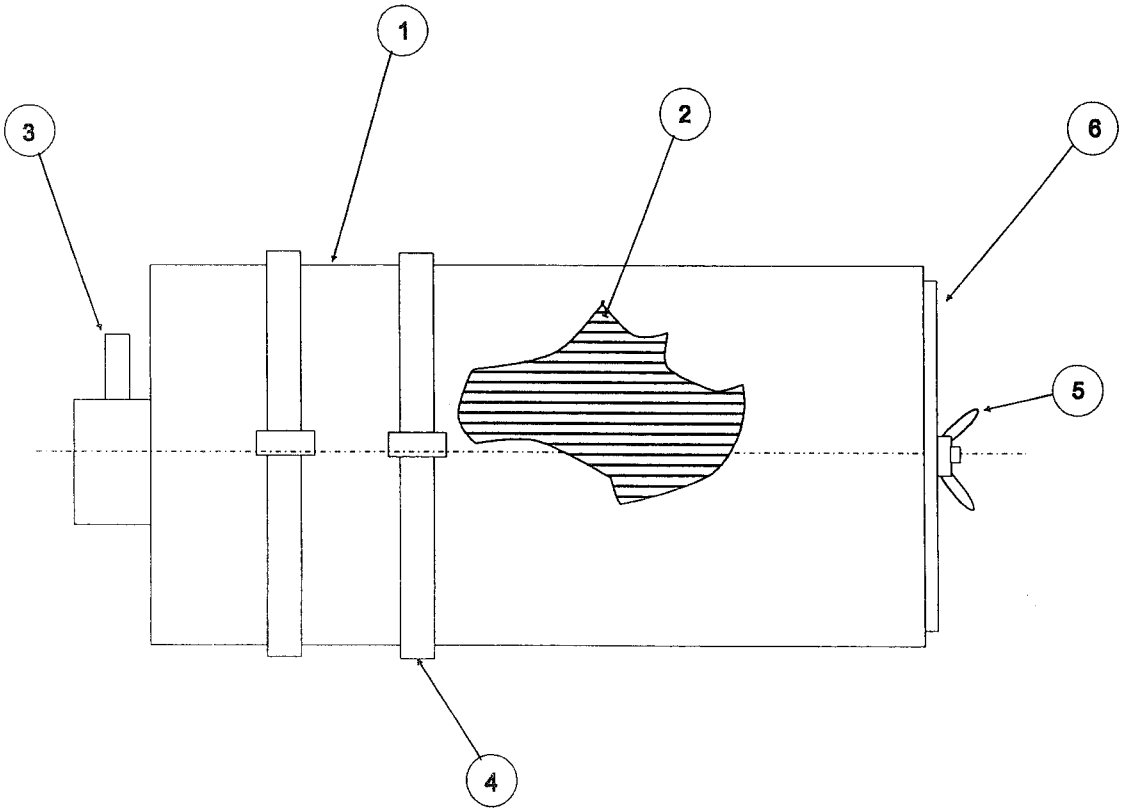


Figure 7-5. Air Inlet Filter Assembly

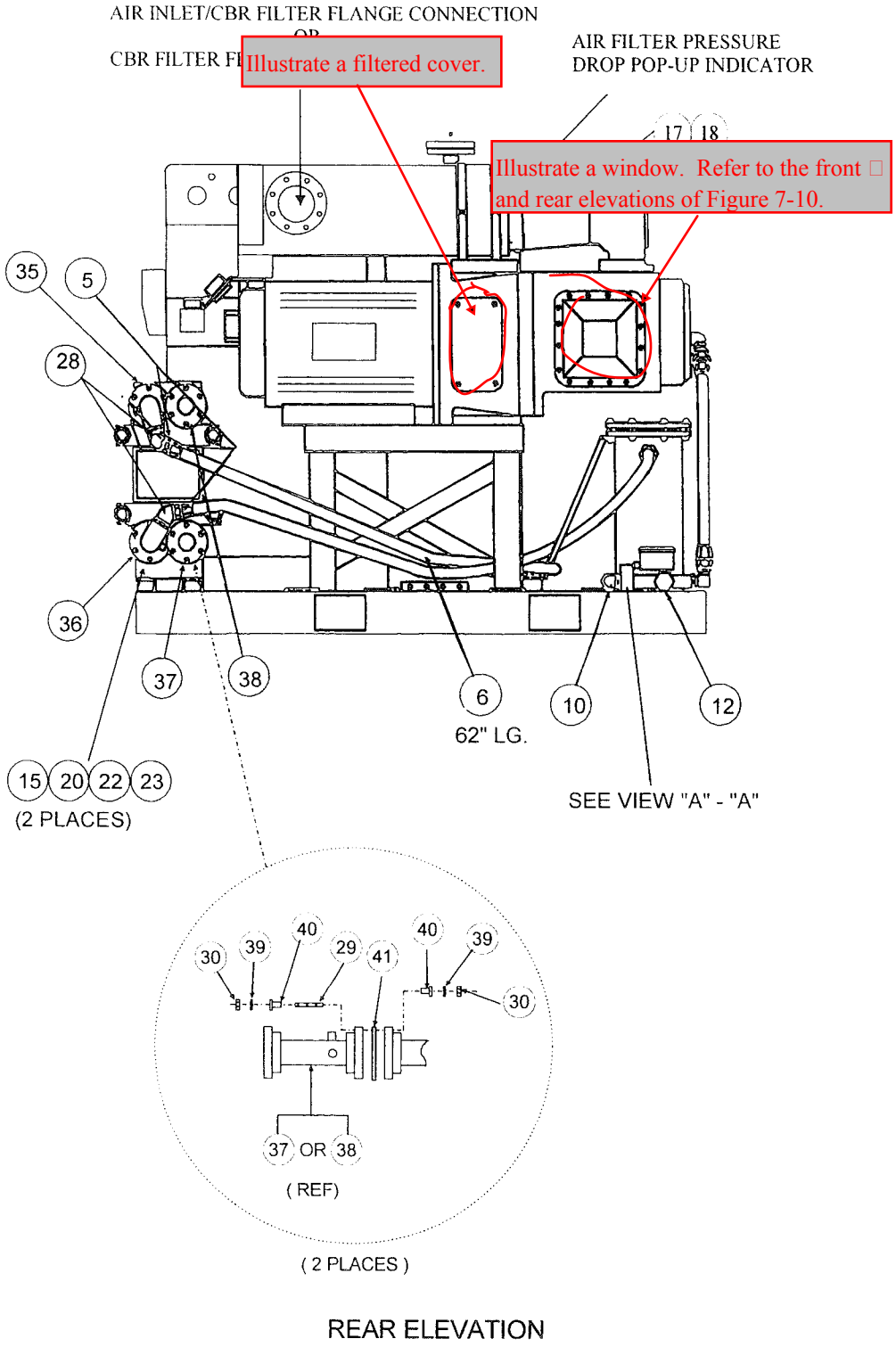
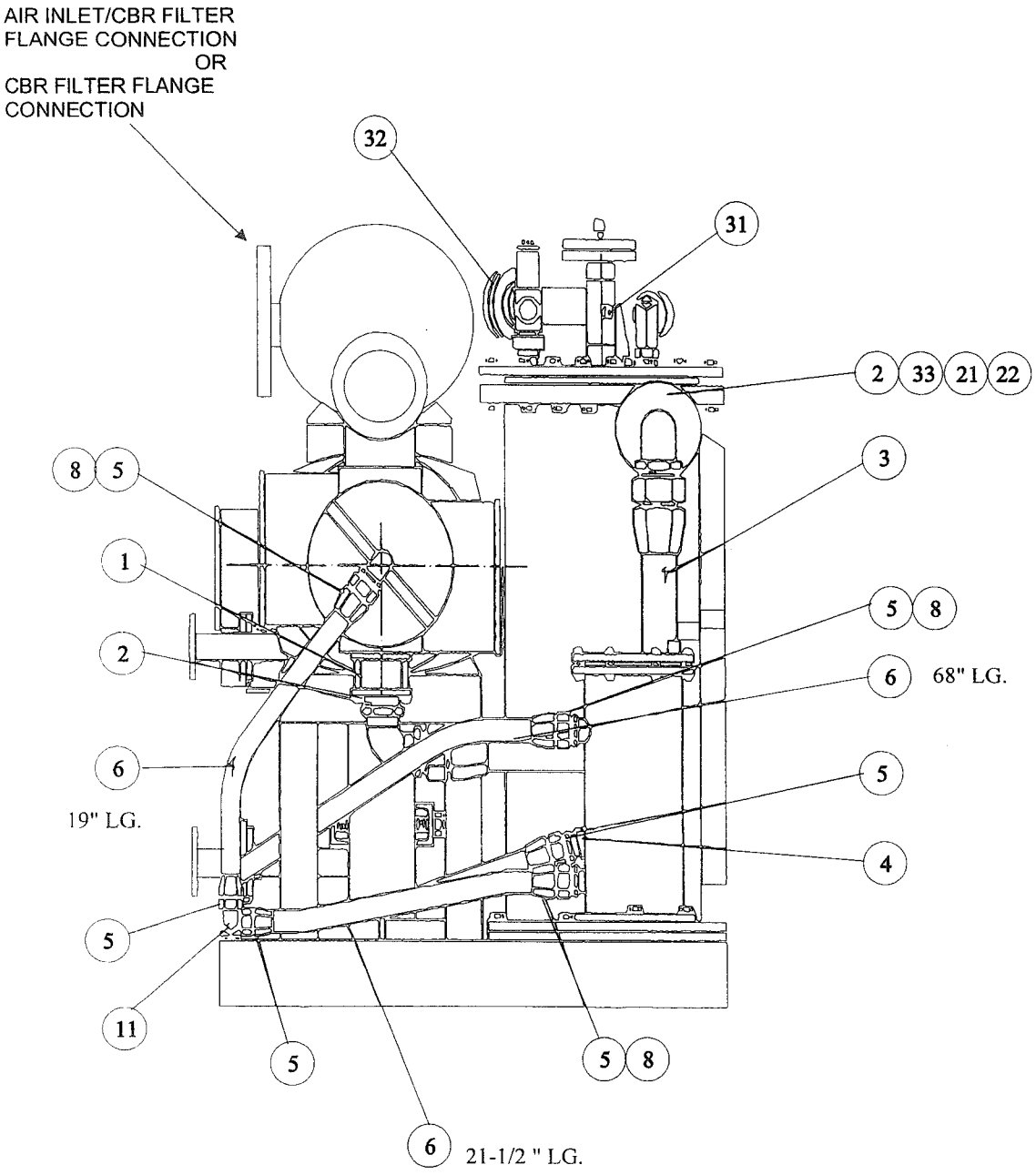
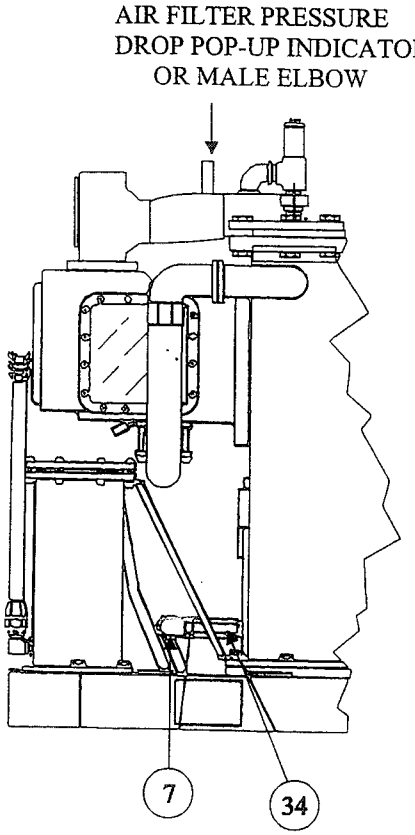


Figure 7-6. Main Piping Assembly (sheet 1 of 3)

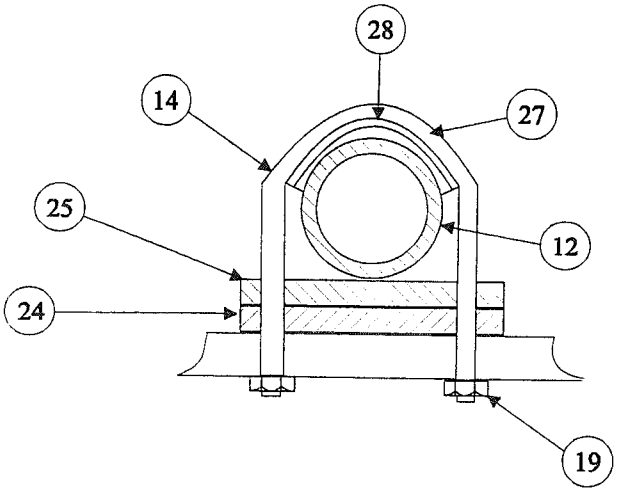


END ELEVATION

Figure 7-6. Main Piping Assembly (sheet 2 of 3)

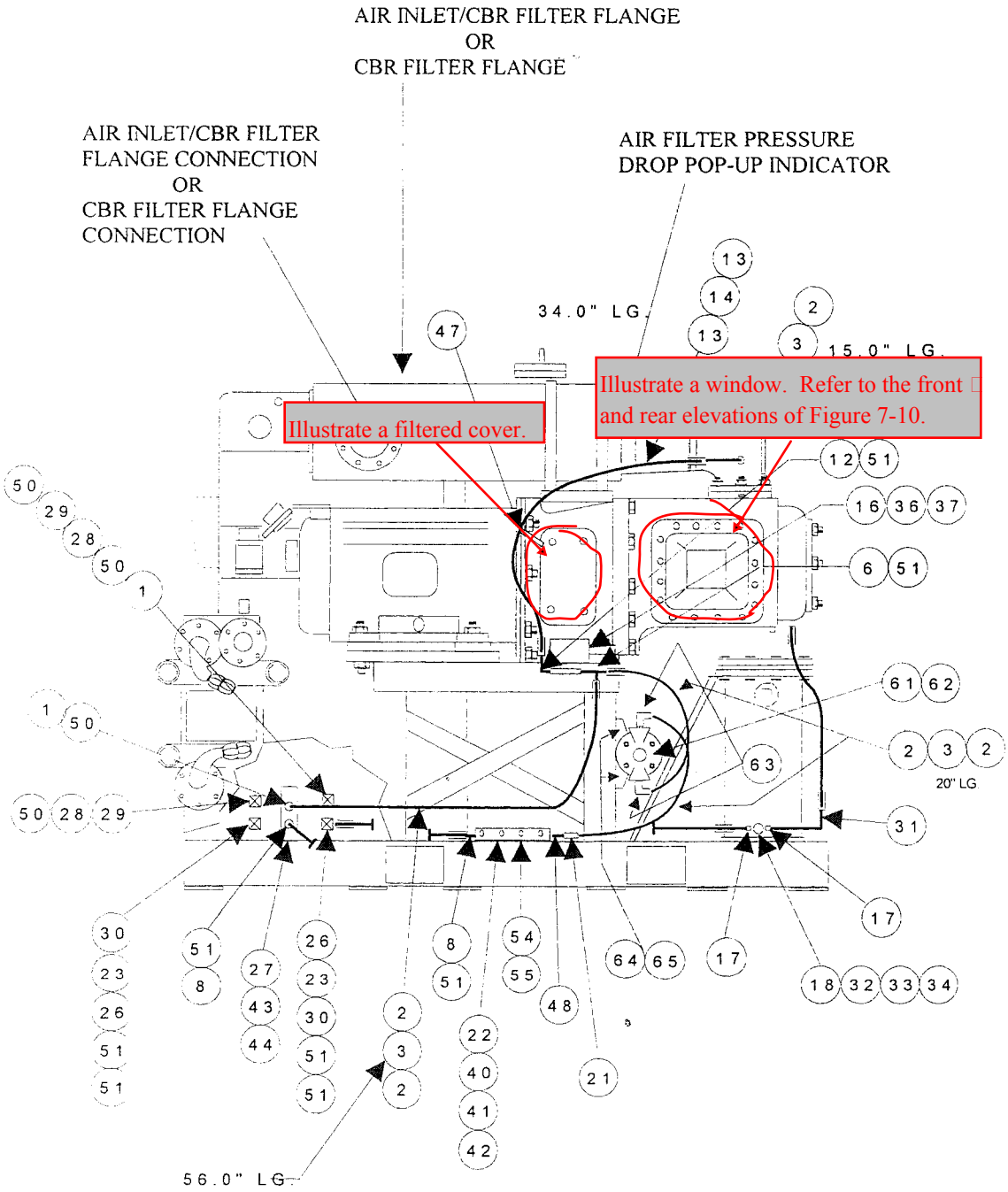


PARTIAL FRONT ELEVATION



VIEW "A" - "A"
SOLENOID VALVE ISOLATION MOUNTING
(TYPICAL BOTH ENDS OF VALVE)

Figure 7-6. Main Piping Assembly (sheet 3 of 3)



REAR ELEVATION

Figure 7-7. Drain and Fill Piping (sheet 1 of 5)

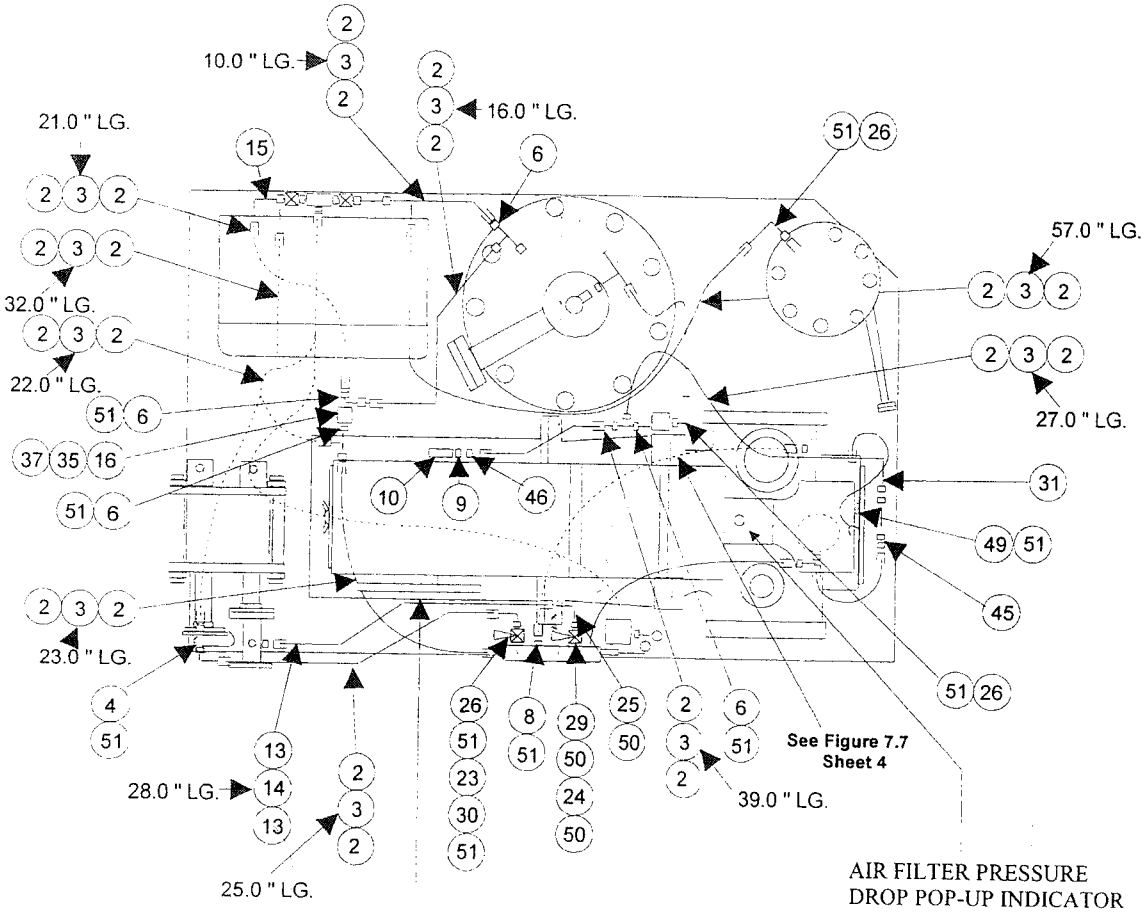
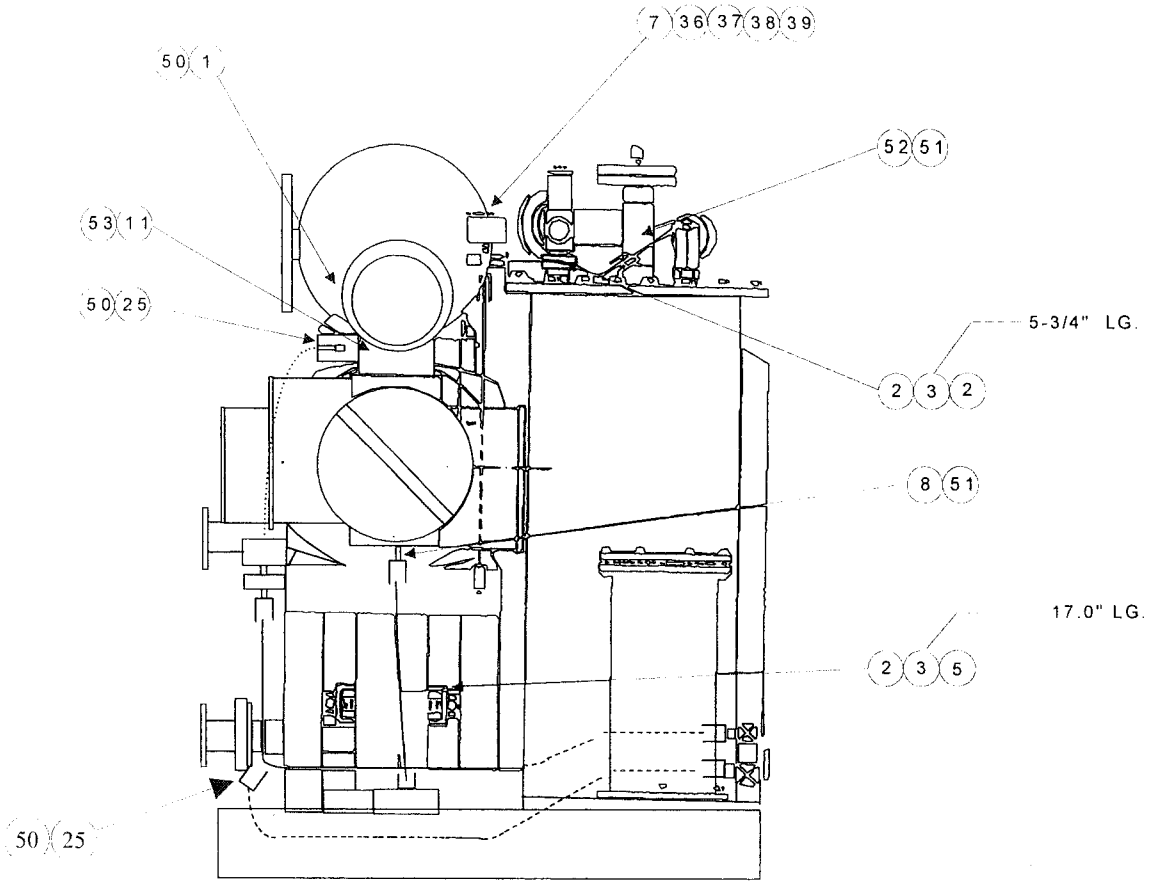


Figure 7-7. Drain and Fill Piping (sheet 2 of 5)



COMPRESSOR END - ELEVATION

Figure 7-7. Drain and Fill Piping (sheet 3 of 5)

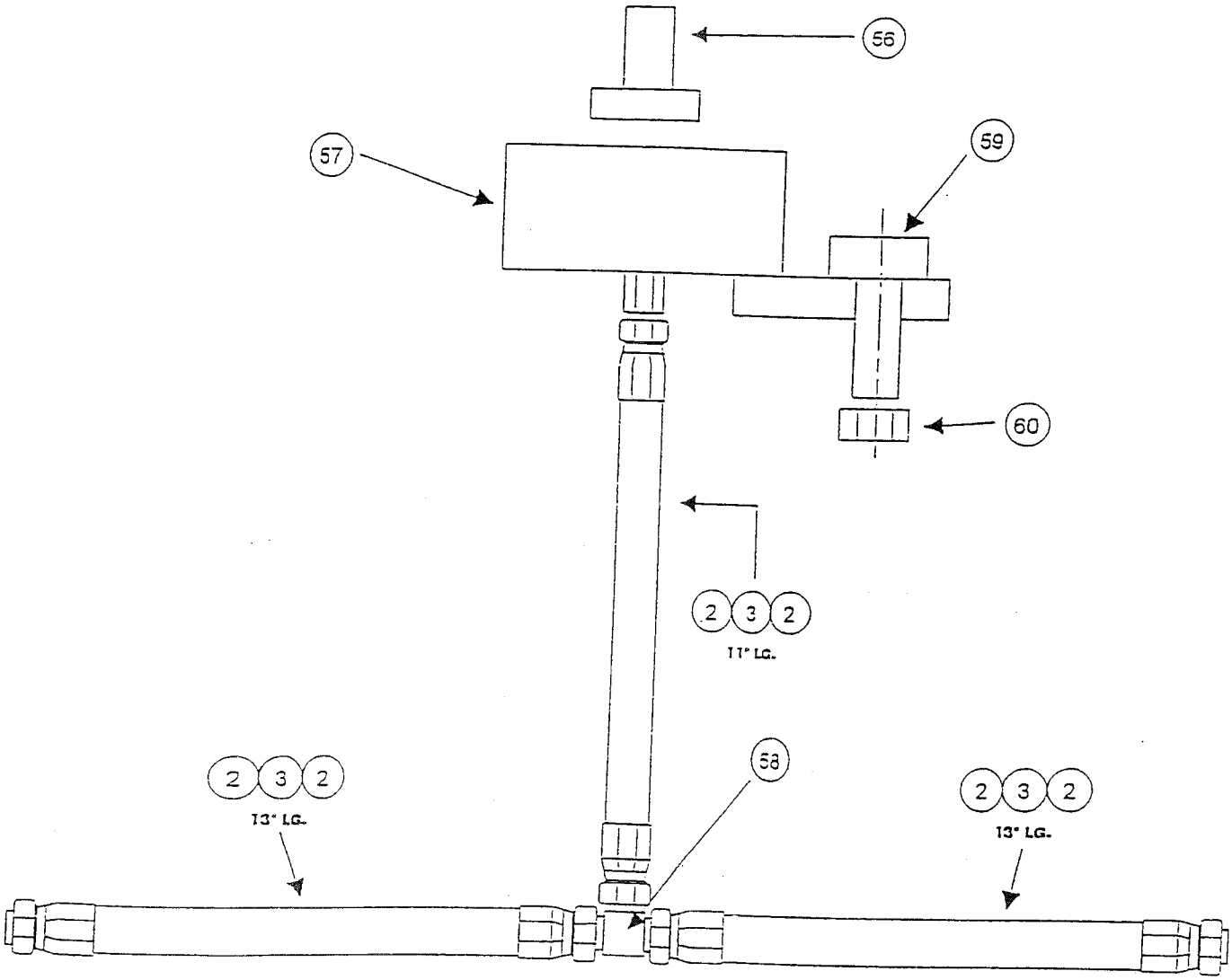


Figure 7-7. Drain and Fill Piping (sheet 4 of 5)

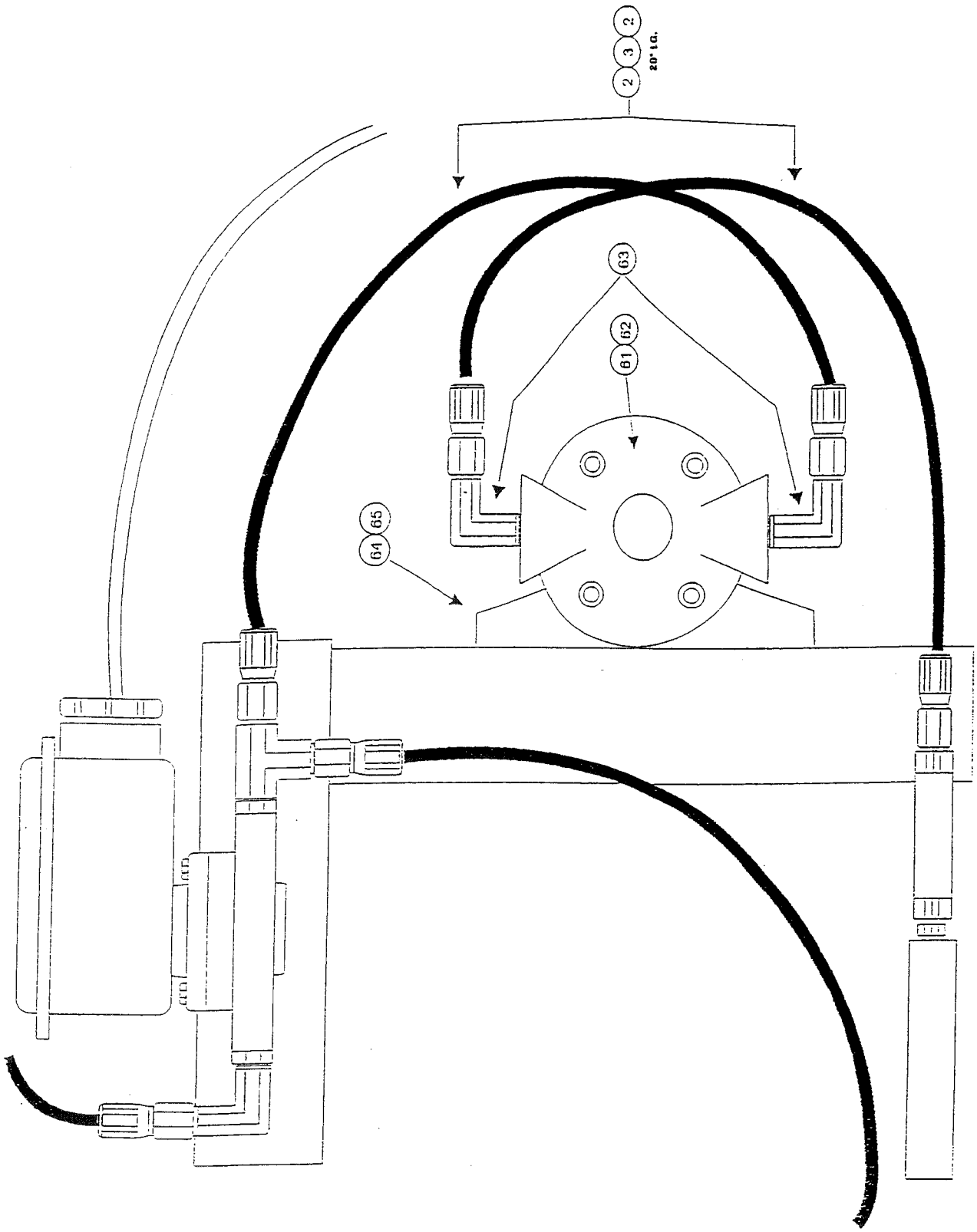


Figure 7-7. Drain and Fill Piping (sheet 5 of 5)

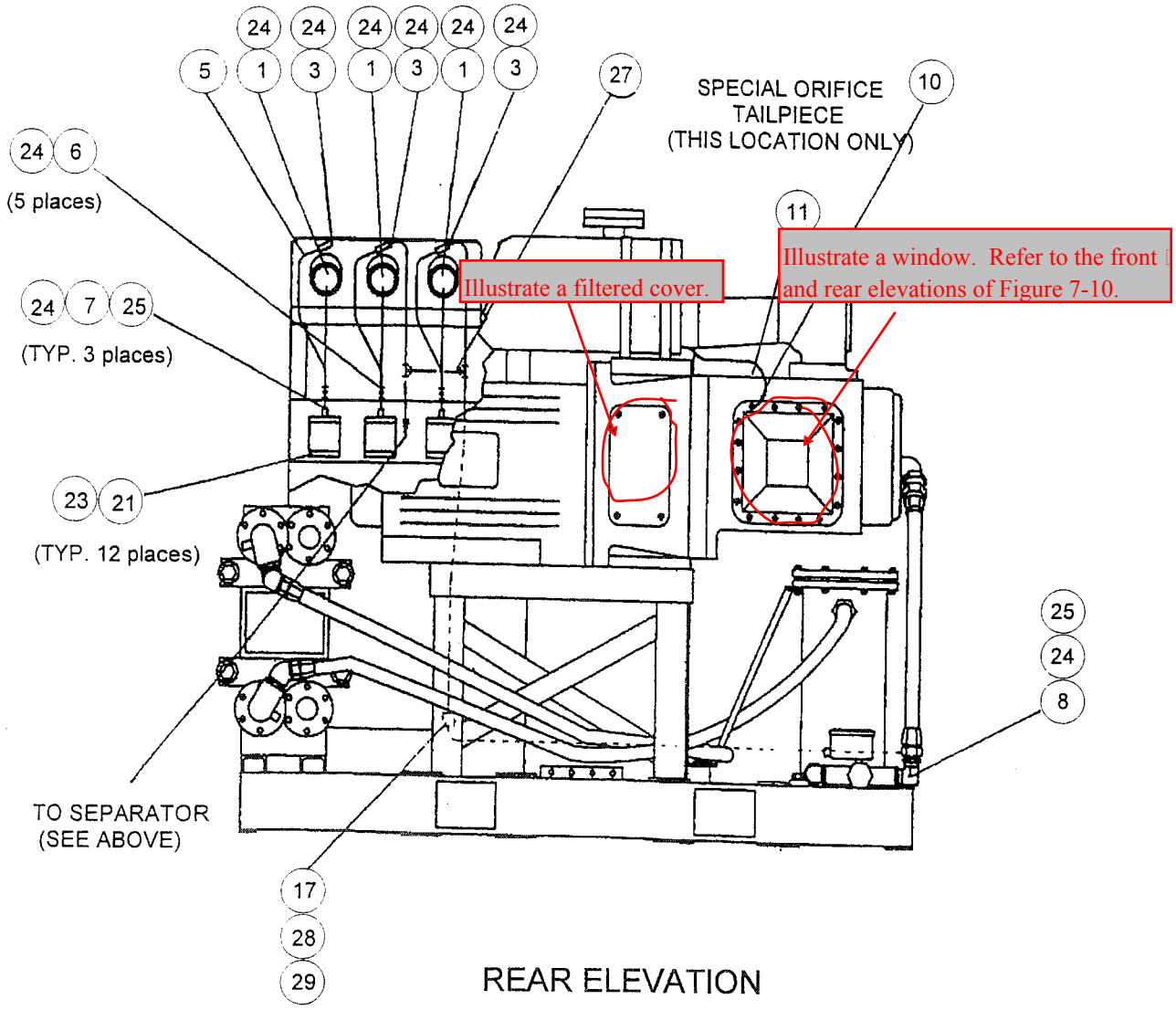


Figure 7-8. Instrumentation Arrangement (sheet 1 of 3)

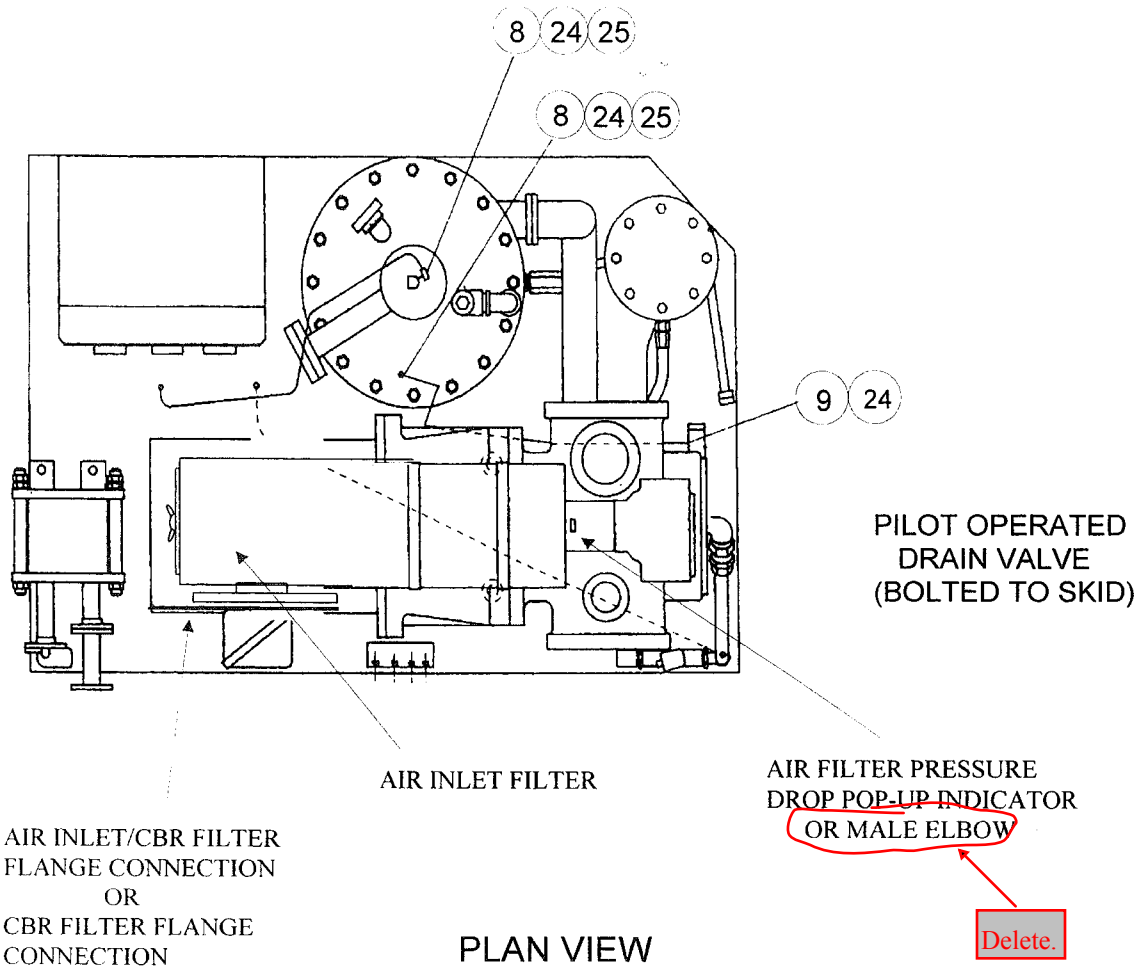


Figure 7-8. Instrumentation Arrangement (sheet 2 of 3)

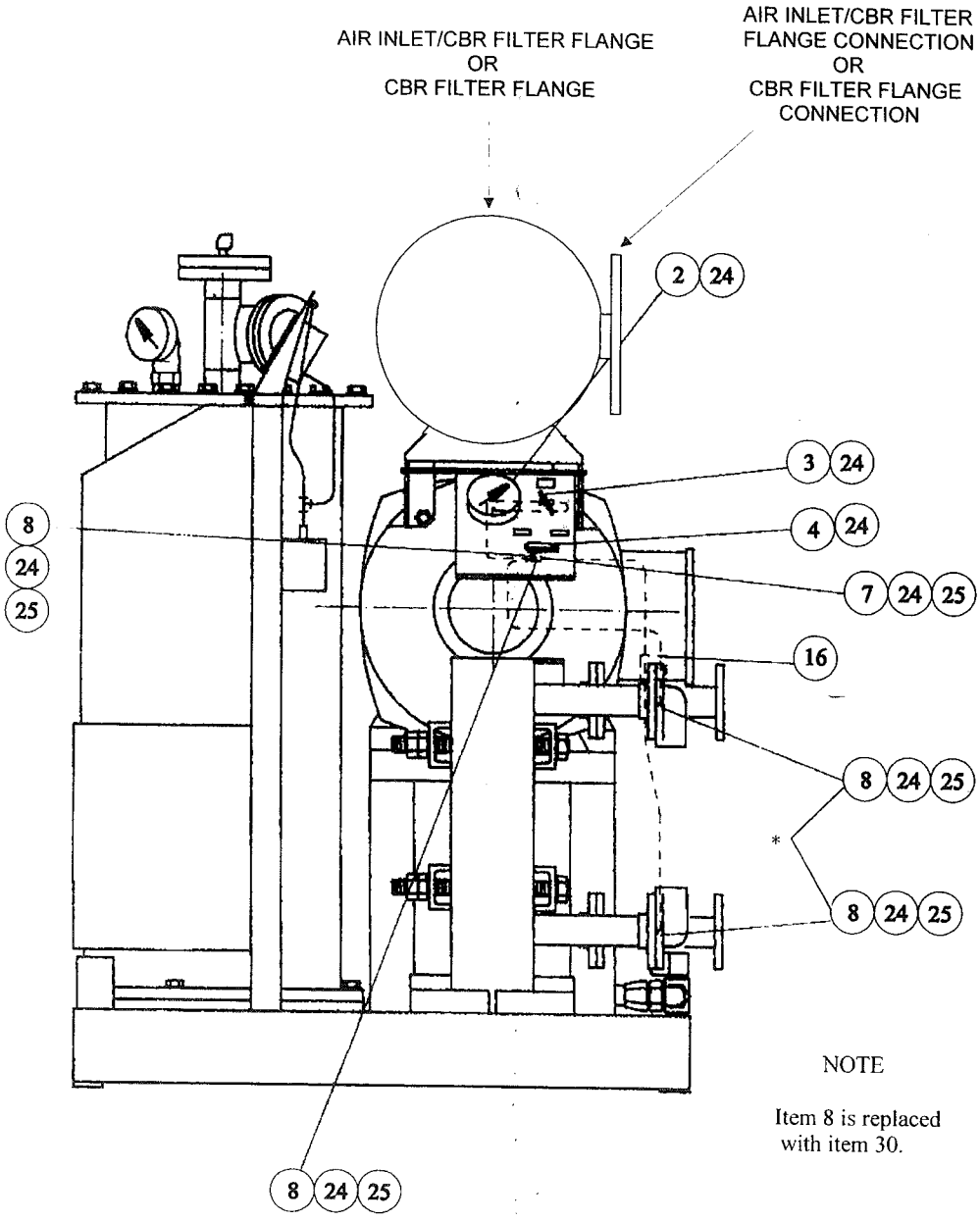
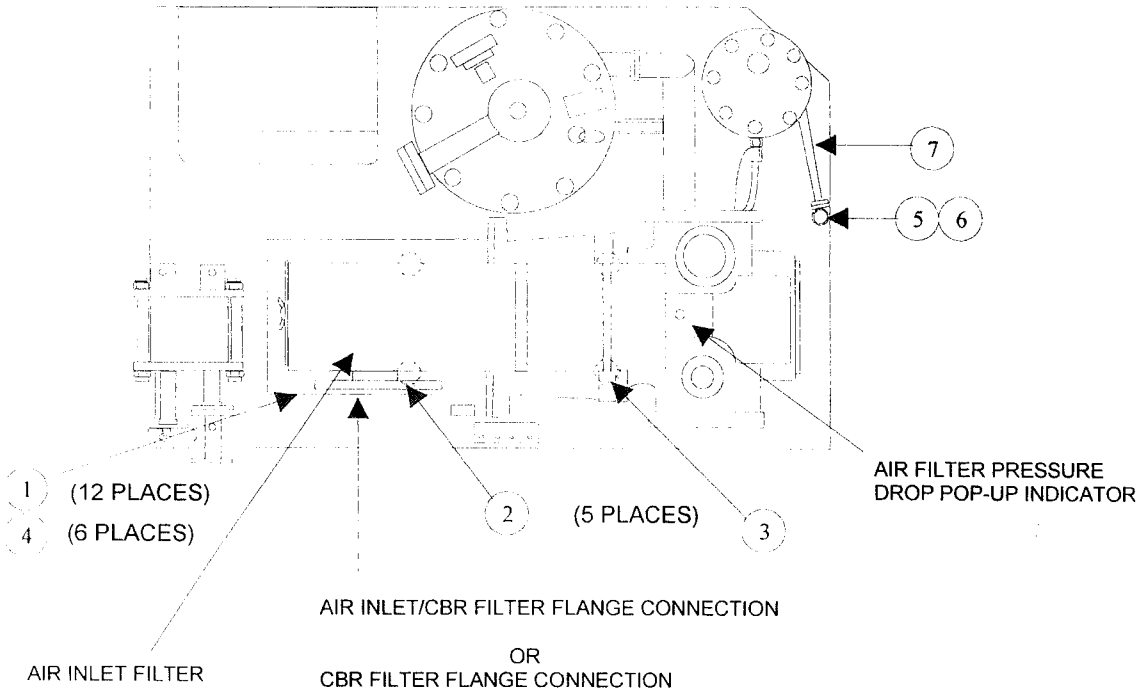


Figure 7-8. Instrumentation Arrangement (sheet 3 of 3)



PLAN VIEW

Figure 7-9. Miscellaneous Parts

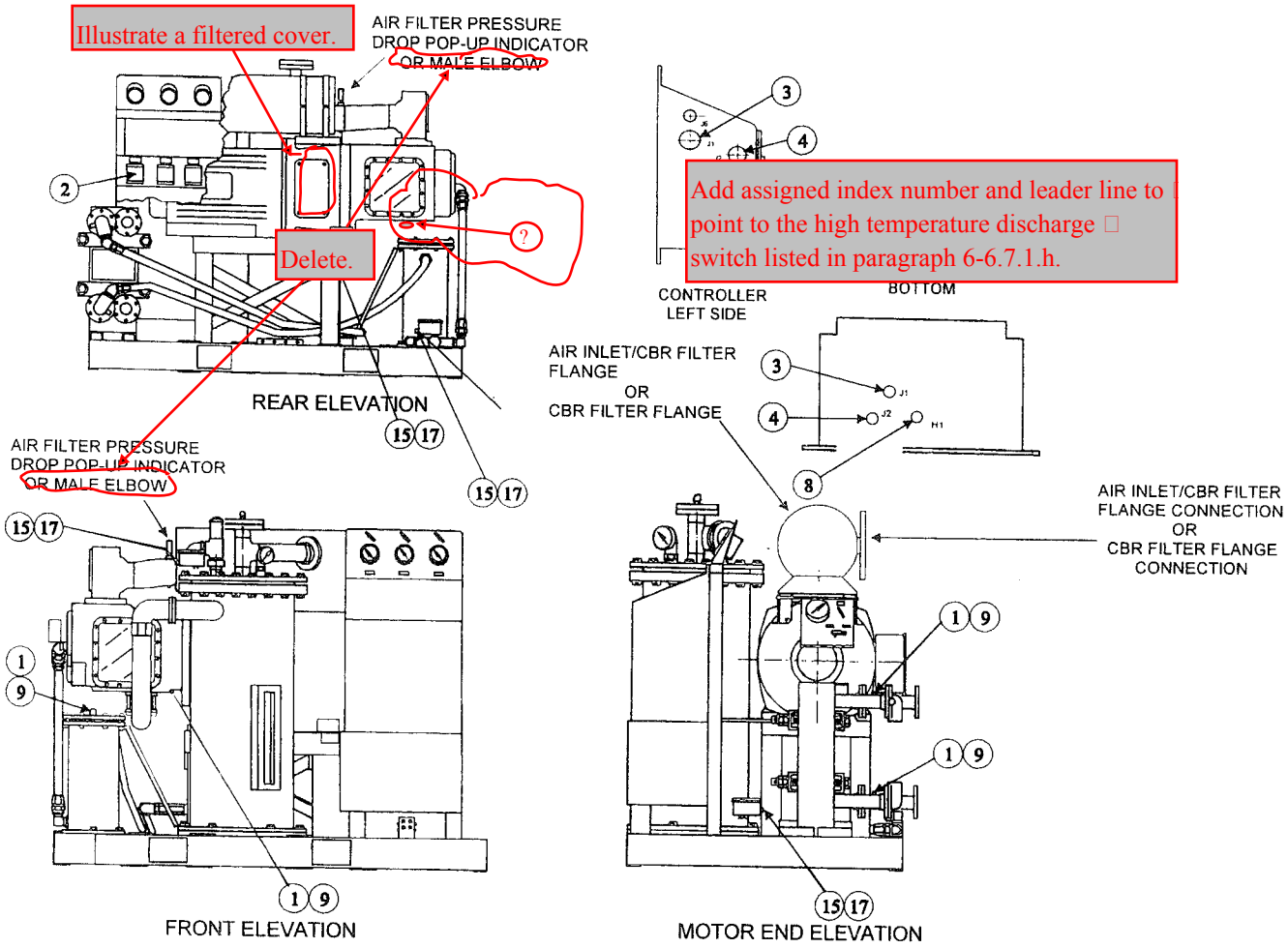


Figure 7-10. External Parts Package

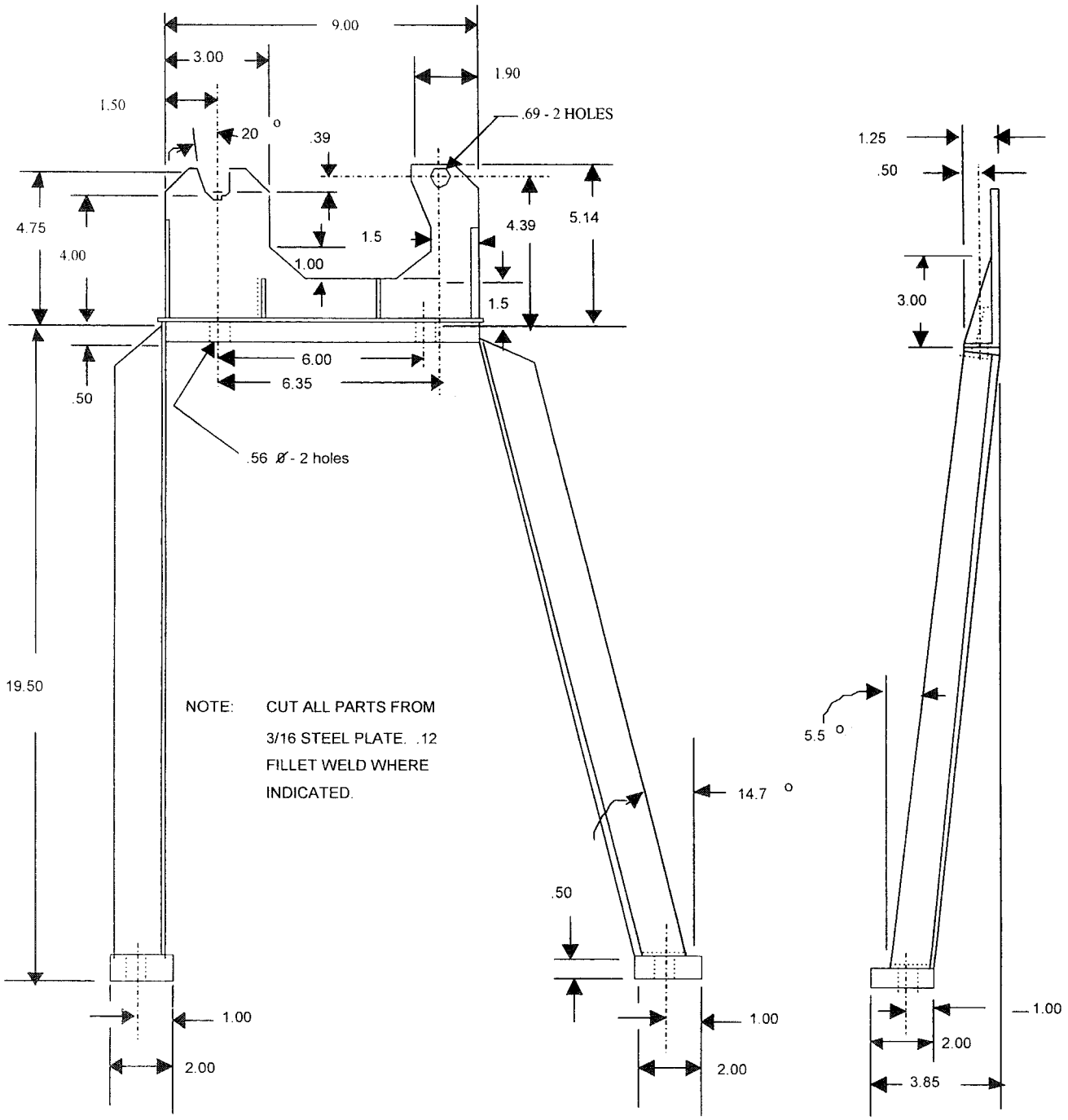


Figure 7-11. Air-End Support Fixture

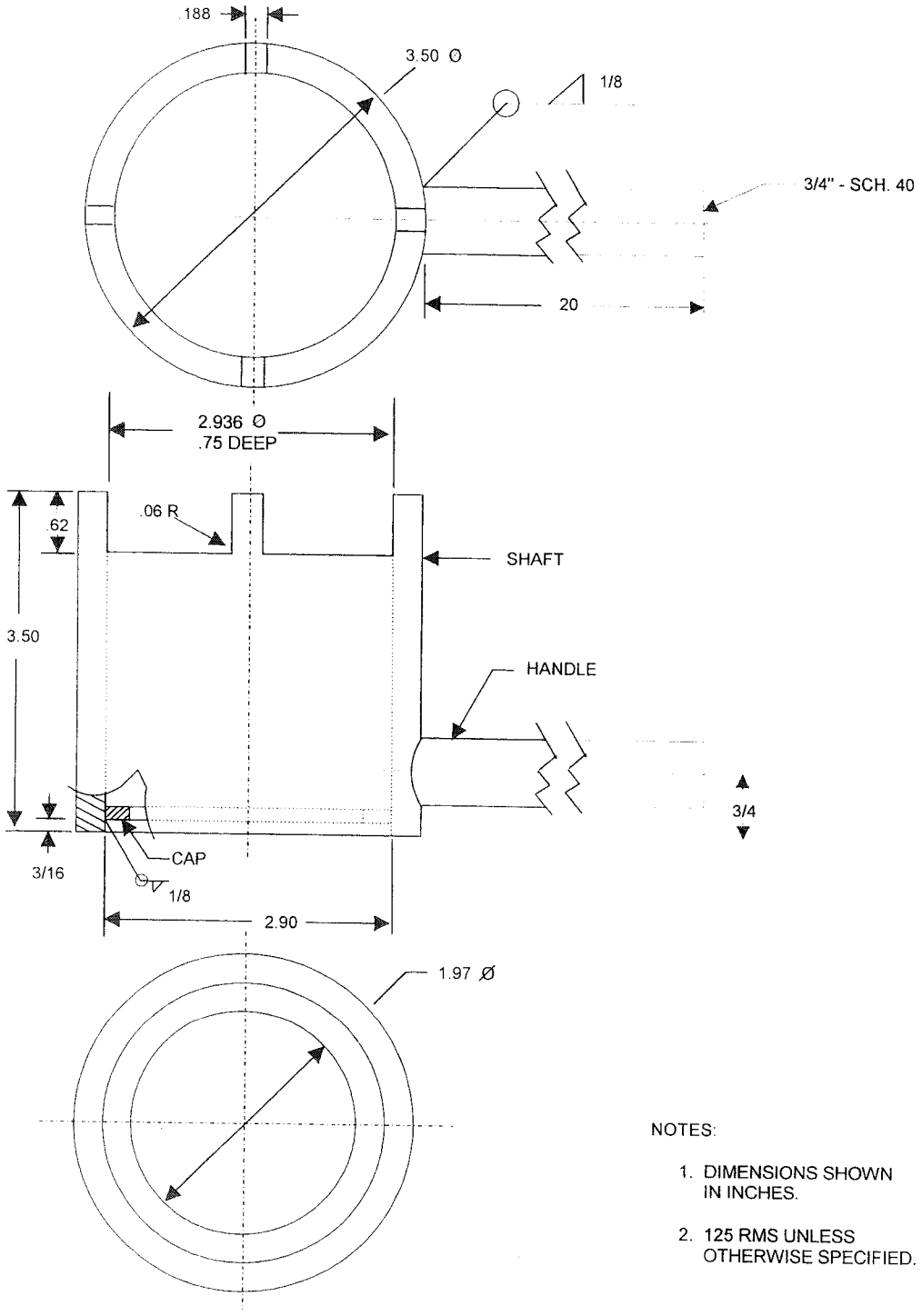


Figure 7-12. Locknut Tool

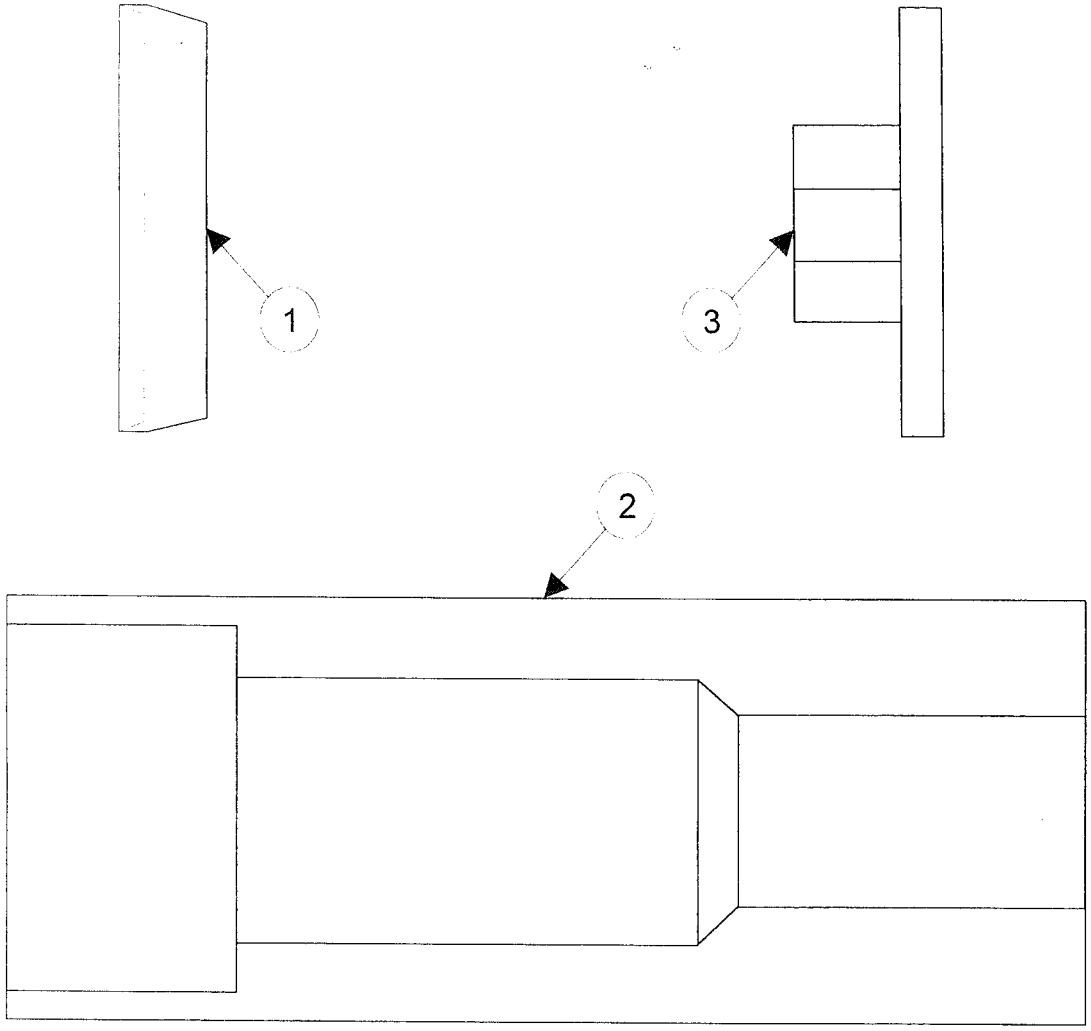
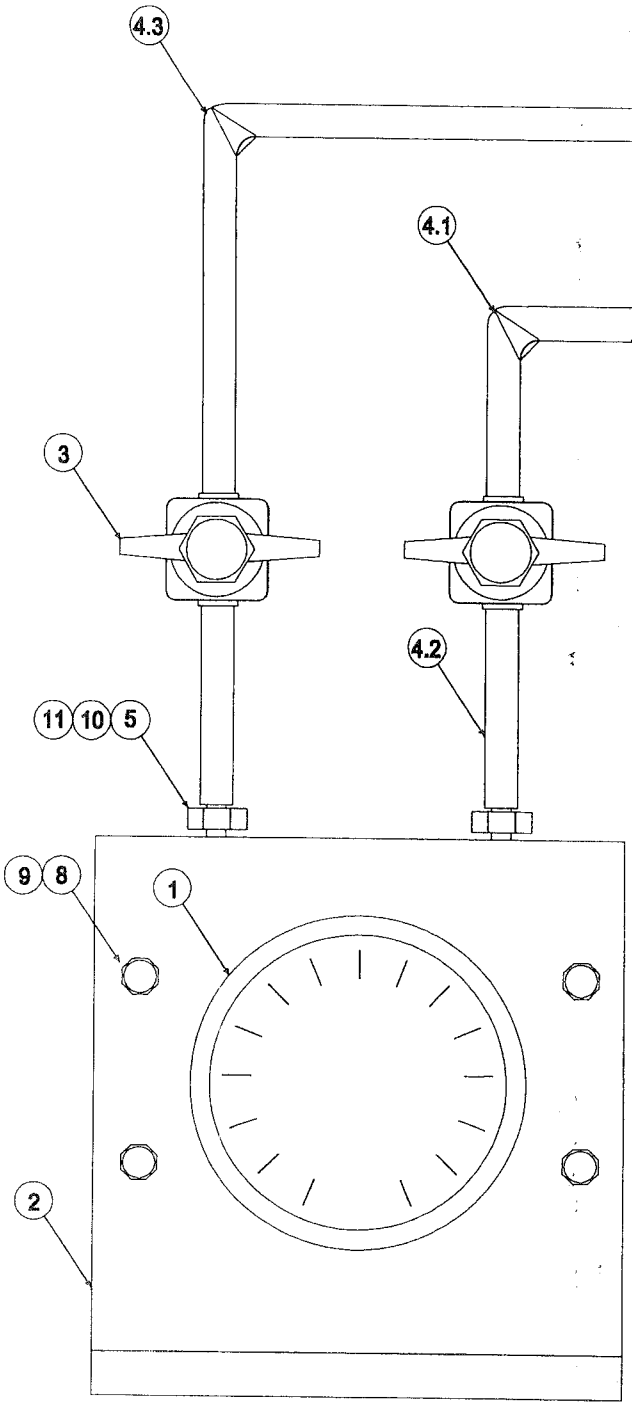


Figure 7-13. V-Ring Installation Tool



LEGEND

1. DIFFERENTIAL PRESSURE GAUGE
2. MOUNTING BRACKET
3. GAUGE VALVE
4.1 TUBING
4.2 TUBING
4.3 TUBING
5. MALE CONNECTOR
6. ORIFICE PLATE
7. ELBOW
8. HEX HEAD CAPSCREWS
9. NUTS
10. O-RING
11. O-RING

Figure 7-14. Flow Meter Assembly

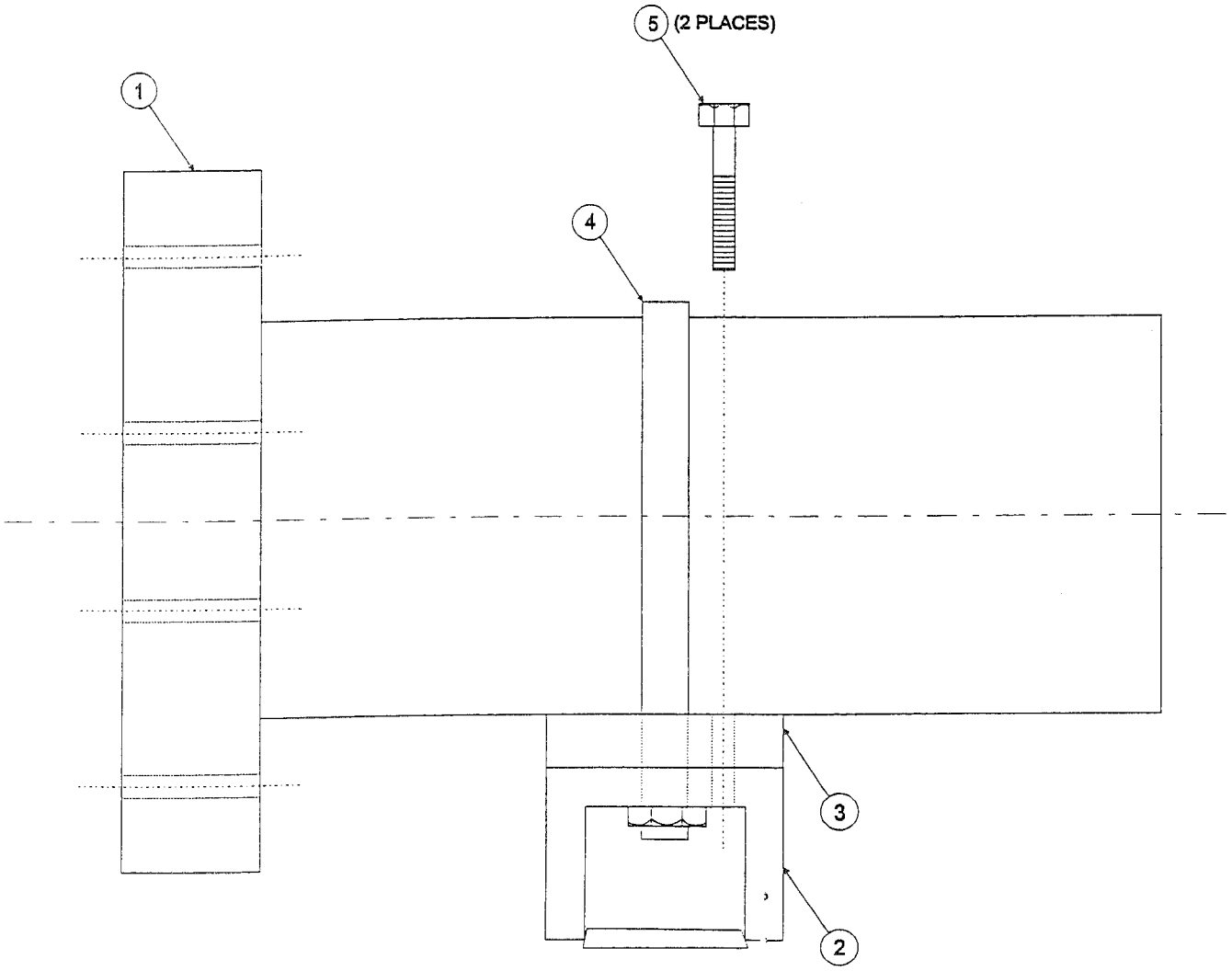


Figure 7-15. CBR Filter Flange Assembly

CHAPTER 8
INSTALLATION

8-1 INTRODUCTION.

This chapter provides the information and drawings required for installation of the model STAR 200 low pressure air compressor (LPAC). It includes site information, tool and equipment requirements, unpacking and repacking, preparation for installation, input requirements, installation procedures and data necessary for the proper installation of the LPAC. This chapter also includes a three-phase installation checkout to demonstrate that all functions of the LPAC are fully operable.

8-2 INSTALLATION DRAWINGS.

The following Figures provide information necessary for the LPAC installation:

a) Figure FO-1 - General Arrangement
b) Figure FO-2 - General Wiring
c) Figure 8-1 - Installation Standards Summary Sheet

Figure FO-1 provides dimensional data and the location and type of all piping connections. Figure FO-2 gives electrical wiring information and connections. Figure 8-1 indicates information to be recorded during installation checkout.

8-3 SITE INFORMATION.

8-3.1 Foundation Requirements. When selecting a site for the LPAC, it is essential to consider the equipment footprint and accessibility to LPAC for operation and service. Figure FO-1 shows the overall LPAC dimensions. A three-foot clear area should be left on all sides of the LPAC to allow for operation and servicing. Additionally, thought should be given to the necessity of getting a hoist to the LPAC should it become necessary to remove and replace major assemblies. The programmable logic controller (PLC) and gage panel require operator interface and must be located within the operator's field of vision and reach. No special machining is necessary on the foundation for resilient mount installation unless specified on the SHIPALT drawing. Any variation from true level plane of the heights at the mount location should be corrected by using shims cut from standard thickness of plate to the nearest 1/16". A tapered shim must be installed under the mount if the mount will be tilted 3 degrees or more relative to the horizontal plane of the foundation.

8-3.2 Interface Requirements. (Refer to Paragraph 8-7 for specific requirements.) The LPAC requires sources of seawater, potable water, and 3-Phase, 440 VAC electrical power. Suitable drains must be provided for the discharged seawater and potable water. LPAC air intake is taken directly from the compartment and/or from the ship's Chemical, Biological, and Radiological (CBR) filter. The site selected should provide compartment air between 40 and 122 degrees Fahrenheit (F), and below 50 percent humidity. The output of the LPAC is connected to the ship's low-pressure air system.

8-4 TOOLS AND MATERIAL REQUIRED FOR INSTALLATION.

8-4.1 Tools and Equipment Required. The following tools and equipment are required to transport and install the LPAC.

NOTE

The LPAC skid has openings on the front and back to accept fork lift cantilevers or hoist slings. (Refer to Figure FO-1 for their location and size.)

a) Lifting and handling equipment suitable for a 2-ton load, such as a fork lift with cantilevers that extend under the entire bottom of the crate or unit.

or

An overhead crane with a sling that loops under the bottom of the crate or unit and fully supports the unit skid.

b) Welding and brazing equipment to attach pipe fittings.

Air Compressor STAR 200
Installation Standards Summary

Date _____
Unit Serial Number _____
Installed in _____

Record test indications obtained during checkout

Paragraph No.	Description	Recorded Results	Normal Range
8-9.3e	Compressor Rotation Check	_____ (CW) (CCW)	CW from motor end
8-9.3g	Inj. Water Pressure	_____ psig	25-105 psig
(Table 2-3)	Disc. Air Pressure	_____ psig	125 psig
	Disc. Air Temp.	_____ deg. F	122 deg. F (Max)
	Cycle ON System Pressure	_____ psig	105-115 psig
	Cycle OFF System Pressure	_____ psig	115 - 125 psig
	MOTOR RUNNING Indicator Light	_____ (OK)	ON when compressor running & OFF when compressor stopped.
	Unloaded Operation	_____ (OK)	When system press. reaches default upper pressure setting, the compressor runs unloaded for 10 min. before stopping.
	PLC Touchscreen Display	_____ (OK)	Sequentially displays compressor operating data.
	STOP/RESET Pushbutton Switch	_____ (OK)	Terminates manual operation when pressed.
8-9.3j (Table 2-4)	Compressor Manual Operation	_____ (OK)	Compressor operation conforms to Table 2-4.
8-9.3k (Table 2-5)	Compressor Battle Override Operation	_____ (OK)	Compressor operation conforms to Table 2-5.

_____
(Person performing tests)

_____
(Shop)

Figure 8-1. Installation Standards Summary Sheet.

c) Tools normally available to mechanics and electricians, such as wrenches and screwdrivers.

8-4.2 Material Required. The following material, supplied by the installer, is required for installation:

a) Suitable mounting pad for bolting the unit down hard or suitable resilient mounts. (Refer to Figure FO-1 for location of mounting holes.)

b) Three lengths of piping with MIL-F-20042, 2"-150# Navy flanges for connecting the following LPAC connections to the ship's systems (refer to Figure FO-1 for location of the connection points) (length to be determined by the installing activity):

(1) Heat exchanger seawater inlet made from bronze to the ship's seawater supply system.

(2) Heat exchanger seawater outlet made from bronze to the ship's seawater discharge system.

(3) Final air discharge connection made from stainless steel to the ship's low-pressure air system.

NOTE

If the LPAC is to be mounted on resilient mounts a section of flexible piping must be inserted between the LPAC and the rigid piping.

c) Four lengths of piping with MIL-STD-MS16142 fittings for connecting the following LPAC connections to the ship's systems (refer to Figure FO-1 for location of the connection points) (length to be determined by the installing activity):

(1) Heat exchanger, water filter, and separator/holding tank potable water drain (single point of connection) to the ship's potable water discharge system.

(2) The connection is 3/4"-16UNF female straight thread port in the drain manifold block (refer to Figure FO-1).

(3) LPAC air-end potable water drain to the ship's potable water discharge system. This should be a short hose into an open funnel to avoid flooding the air-end with a suction effect caused by air pressure lower than required to close the pilot valve. The connection is a 3/4"-16UNF female straight thread port in the drain manifold block (refer to Figure FO-1).

(4) Heat exchanger seawater drain to the ship's seawater discharge system. The connection is a 9/16"-18UNF female straight thread port in the drain manifold block (refer to Figure FO-1).

(5) Potable water input to the ship's potable water distribution system. The connection is a 9/16"-18UNF female straight thread port in the drain manifold block (refer to Figure FO-1).

NOTE

If the LPAC is mounted on resilient mounts flexible pipe sections will be required between rigid piping and the LPAC.

d) A suitable bonding strap to go between the LPAC skid and the ship structure.

e) A suitable length of electrical cable to supply the LPAC with 3-Phase, 440 VAC, 71.5 AMP service. Length to be determined by the installing activity (refer to Figures FO-1 and FO-2).

f) Stop valves for the seawater supply and drain piping; potable water supply and drain piping; and low pressure air discharge piping. The heat exchanger has a design pressure drop of 2 pounds per square inch (psi) at a flow-rate of 40 gallons-per-minute (gpm).

g) Suitable check valve for the low-pressure air discharge piping.

h) Suitable piping for connection of the compressor's shipboard system pressure connection to the ship's low-pressure air system. The connection is a 70/30 copper nickel socket weld tailpiece for a 1/4" diameter tube. Length to be determined by the installing activity. (Refer to Figure FO-1 for the connection point.)

NOTE

If LPAC is mounted on resilient mounts a flexible pipe section will be required between the LPAC and the rigid piping.

8-5 UNPACKING AND REPACKING.

8-5.1 Unpacking.

WARNING

The crated LPAC weighs approximately 4000 pounds. Use only equipment rated for this weight for moving and installation of the unit. Serious injury may result to personnel if underrated equipment is used.

CAUTION

Care must be used when transporting and handling the crated LPAC to prevent damage to its contents. Before uncrating, move the LPAC as near as possible to the installation location.

Using hammer and pry bar carefully disassemble the packing crate. Examine the crate interior for loose items. Dispose of the packing material in accordance with local instructions. Visually inspect the LPAC unit for shipping damage, such as bent or broken tubing, gauges, guards and supports, etc.

NOTE

LPAC's shipped without resilient mounts are bolted to wooden pallets with 1/2" diameter carriage bolts. LPAC's shipped with resilient mounts are bolted to wooden pallets with 3/4" diameter carriage bolts.

Unbolt the LPAC from the pallet and lift it by its skid, using care to avoid damaging piping and instrumentation.

8-5.2 Repacking and Wrapping/Crating.

8-5.2.1 Repacking. Removal of LPAC from ship is not covered. It is assumed that LPAC is off the ship. When the LPAC unit is to be repacked for storage or shipment:

a) Drain all seawater and potable water from LPAC.

b) Install blind flanges with gaskets on open flange connections and plug all other openings. Tag locations to ensure removal of flanges and plugs on reinstallation.

c) Cover the package with an approved material to protect from direct sunlight, dust, dirt, water, or other foreign particles.

d) Protect control panel, gauges, tubing, hoses, and wiring from physical damage.

e) Store in a dry area when the temperature is above 32 degrees F.

8-5.2.2 Wrapping/Crating. The wrapping/crating procedures are as follows:

a) Package the LPAC (IAW MIL-P-116, Method IIA).

b) The shipping container is to be per MIL-C-104A, Type 1, Class 2, Style A. Construct a box, making four sides with bottom and top separately for final assembly.

c) Prepare a barrier envelope, including transparent panel with anchor holes per MIL-E-6060, Sketch 12.1.1.1. Apply the transparent panel, using tape on all four sides. Place the envelope on the box base with anchor bolts protruding through gasketed holes. Seal all openings with tape conforming to JAN-P-127, Grade B; or barrier material conforming to MIL-B-121, secured with tape.

d) Seal all openings in the LPAC drive motor with pressure sensitive tape conforming to PPP-T-60, Type I, Class 1. Affix notice to "Remove Tape Prior to Operation Of Motor".

e) Seal LPAC controller operating panel with tape conforming to JAN-P-127, Type I, Grade B. Mask all gauge dial glass with barrier material conforming to MIL-B-121, Grade A, Type I. Then cover with plywood or fiberboard secured in place with pressure sensitive tape.

WARNING

The uncrated LPAC weighs approximately 3200 pounds. Use only equipment rated for this weight for moving the LPAC unit. Serious injury may result to personnel if underrated equipment is used.

f) Place the LPAC unit on the box base over the anchor bolts. Using flange washers, place nuts on the anchor bolts and tighten. Be certain the gaskets are in place.

g) Secure desiccant and moisture indicator.

h) Fold envelope over LPAC unit with transparent panel located to expose moisture indicator. Heat seal edges. Draw vacuum envelope and seal end.

i) The stored LPAC unit must be inspected periodically. If moisture is present, corrective action must be taken to prevent hardware damage. Annually, apply additional preservation treatment if required.

8-6 PREPARATION OF FOUNDATION.

The LPAC is to be mounted on a reinforced steel deck with 6 inch or larger "I" beams. Figure FO-1 shows the installation arrangement and location of the mounting holes. The LPAC and its skid are aligned at the factory. If the LPAC is located on a rigid, cast, and planed foundation, no shimming is required and the LPAC can be bolted to the foundation without additional alignment. However, if the LPAC is to be mounted on various other types of foundations, additional preparation is required. When solid-mounted on fabricated structures or deck plates, make the mounting surface as flat and smooth as possible by grinding or planing. Collar shims must then be individually ground to size to fit under the foundation bolt holes of the LPAC skid. The collar shims must be at least one-half inch thick. Drilling for foundation bolts must be in accordance with the dimensions shown in Figure FO-1. The LPAC skid foundation bolt holes are drilled at the factory to accept foundation bolts one-sixteenth inch smaller in diameter.

8-7 INPUT REQUIREMENTS.

The LPAC requires the following inputs:

a) POWER - 440 VAC, 3 phase, 60 Hz, 71.5 amp (running fully loaded).

b) INTAKE AIR - From CBR filter or compartment air, 40 to 122 degrees F, 12.7 to 18.7 psia, 0 to 50 percent humidity.

c) SEAWATER - A seawater supply of 40 gpm, with an operating temperature below 95 degrees F, is required for cooling.

d) POTABLE WATER - A potable water supply of 40 gpm, at 25 to 105 psig is required for lubrication and sealing of the LPAC's internal parts.

8-8 INSTALLATION PROCEDURES.

8-8.1 Mounting the LPAC. When the installation site is fully prepared mount the LPAC as follows:

WARNING

The uncrated LPAC weighs approximately 3200 pounds. Use only equipment rated for this weight for moving the LPAC. Serious injury may result to personnel if underrated equipment is used.

a) Position LPAC over foundation holes with any required shims under each corner (refer to Paragraph 8-3.1).

b) Insert two bolts in LPAC end corners (refer to Figure FO-1) and snug up.

c) Use a jacking bar at drive motor end of skid (refer to Figure FO-1) to ease load and permit individual fitting of any required shims over foundation holes (refer to Paragraph 8-3.1).

d) Insert and snug drive motor end corner bolts.

e) With all required corner shims fitted, fully tighten four corner bolts to value shown in Table 6-1.

f) Fit any remaining shims.

g) Insert and tighten remaining foundation bolts to value shown in Table 6-1.

No further alignment of the LPAC is necessary once it has been properly fastened to its foundation.

8-8.2 Piping Interface. Various pipe and tubing connections must be brought to the LPAC by the installing activity (refer to Paragraph 8-4.2). All of this piping must be independently supported against both vibration and shock. The members which form or support root connections on the LPAC are not designed to provide support for structures beyond the LPAC. A length of suitable flexible tubing must be installed just prior to the terminal connection on the LPAC when the unit is mounted on resilient mounts.

CAUTION

The piping and flanges must be cleaned of all welding flux and other foreign matter prior to attaching it to the LPAC. Damage to heat exchanger plates and gaskets, and internal LPAC parts will result if solid matter is allowed to enter the unit.

8-8.2.1 Final Air Discharge. The compressed air discharge connection is located on the top of the separator/holding tank (refer to Figure FO-1). Note that the flow orifice plate (6, Figure 7-14) must be installed with the flow arrow pointing away from the separator and

the port in the orifice plate marked "low" towards the top. Provide a suitable check valve in the discharge air line to prevent the ship's system pressure from backing into the LPAC. Also provide a manual shutoff valve in the ship's discharge air line adjacent to the LPAC to permit maintenance of the LPAC without loss of the ship's air bank pressure.

8-8.2.2 Seawater. The seawater inlet and outlet connections are located on the heat exchanger (refer to Figure FO-1). It is important to protect the heat exchanger seawater flow from inadvertent backpressure caused by unusual or emergency discharge from adjacent equipment into a common overboard line. For this reason, a separate overboard line is recommended. Manual shutoff valves must be provided by the installer to isolate the LPAC for maintenance. A drain for the heat exchanger seawater is also required (refer to Figure FO-1).

8-8.2.3 Potable Water. A supply of potable water is required for internal sealing and lubrication of the LPAC. The water provided must be clean to prevent damage to internal LPAC parts. Drain lines must also be provided. Refer to Figure FO-1 for the location of the supply and two drain connections. A manual shut-off valve must be provided in the supply line for isolation of the LPAC during maintenance.

8-8.2.4 Ship's System Accumulator Pressure. Provide a tube connection from the ship's system accumulator to the LPAC (at rear of gauge panel). The LPAC uses this input to detect start and stop points. A manual shut-off valve must be provided to isolate the LPAC during maintenance.

8-8.2.5 Electrical Connections.

WARNING

To prevent injury or death, ensure electrical circuit is de-energized at source and tagged OUT-OF-SERVICE. Do not work alone.

Refer to Figures FO-1 and FO-2 for power connections. When the LPAC is rigidly mounted to the ships structure, no additional electrical grounding is necessary. When the LPAC is mounted on resilient mounts, ground straps must be installed between the LPAC skid and the ship's structure.

8-8.2.6 CBR Filter. If the CBR Filter and Air Filter are being used, the flange from the CBR filter pipe must be connected to the inlet air filter flange (refer to FO-1). If only the CBR filter is being used, the CBR filter pipe must be connected to the LPAC inlet flange.

8-9 INSTALLATION CHECKOUT.

Installation checkout is performed in three phases. Phase 1 consists of installation inspection and pre-energizing procedures. Phase 2 consists of initial turn-on and tests. Phase 3 consists of installation verification. Installation checkout must be performed in the order presented. Each phase should be completed prior to starting the next phase.

8-9.1 Phase 1- Installation Inspection and Pre-Energizing Procedures. Prior to energizing the LPAC, perform the following procedures to verify that the installation is complete and ready to start.

8-9.1.1 Cleanup. Remove tools and excess installation materials left on and/or around the LPAC. Wipe the LPAC to remove oil, dirt, or other foreign matter. Clean the deck area around the LPAC to remove any oil or grease that could cause personnel to slip.

8-9.1.2 Installation Inspection. Prior to energizing the LPAC, check the following:

a) LPAC installed IAW Paragraph 8-8.1.

b) Electrical connections properly installed and source voltage agrees with drive motor nameplate data.

c) All piping connections installed IAW Paragraph 8-8.2.

d) Clean inlet air filter, ensuring water filter elements are installed.

8-9.1.3 Initial Servicing. Fill the unit with potable water as follows:

a) Remove vent plug located on the top of the water filter.

b) Open **COOLER AND FILTER FILL** valve (14, Figure 2-2). Close valve when water reaches water filter vent plug and replace plug.

c) Open the **COOLER AND FILTER FILL** valve (14, Figure 2-2) again.

d) Open shut-off/injection valve (Figure 1-2) until water starts draining from the air end suction drain line and then close.

e) Close the **COOLER AND FILTER FILL** valve (14, Figure 2-2) and open **SEPARATOR FILL** valve (12, Figure 2-2). When water level in separator assembly reaches the normal level close **SEPARATOR FILL** valve.

8-9.1.4 Pre-Energizing Procedures. The following additional procedures must be accomplished.

WARNING

To prevent injury or death, ensure equipment is de-energized and tagged OUT-OF-SERVICE at the source.

a) Turn OFF and lock-out main power source for LPAC. Install OUT-OF-SERVICE tag.

b) Remove distance piece side cover (7, Figure 6-4). Use drive coupling (8, Figure 6-4) to turn over LPAC by hand. Ensure nothing is binding and that LPAC turns freely. Reinstall distance piece side cover (7, Figure 6-4).

c) Ensure all gauge valves (5, 7, 9, and 19, Figure 2-2) are OPEN.

d) Arrange for LPAC to temporarily discharge against atmospheric pressure only by one of following methods:

(1) Vent ship system air receiver to atmosphere.

(2) Break final air discharge line at LPAC and permit discharge into equipment space.

e) Ensure that all LPAC gauges and relief valves are in calibration.

8-9.2 Phase 2 - Initial Turn-On and Test.
Should any of following tests result in mis-operation or trouble condition refer to Chapter 5 for isolation procedures. Line up ship's seawater system to LPAC and expel any air from the LPAC seawater piping through the heat exchanger seawater drain valve (Figure 1-2).

8-9.3 Phase 3 - Installation Verification.
Should any of following tests result in mis-operation or trouble condition, refer to Chapter 5 for isolation procedures.

a) Restore main source power to LPAC. Remove OUT-OF-SERVICE tag. Ensure the BATTLE OVERRIDE switch (10, Figure 2-1) is set to the OFF position prior to energizing the system.

b) Set **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN**. Set **ON/OFF** selector switch (5, figure 2-1) to **ON**.

c) PLC touchscreen display (3, Figure 2-1) reads:

"COMPRESSOR READY FOR START"

d) Start LPAC using procedures shown in Chapter 2, Table 2-4.

NOTE

Record test results on Installation Standards Summary Sheet (Figure 8-1).

e) Check compressor rotation. Proper rotation is clockwise when viewed from drive-motor end of LPAC.

f) f all conditions are normal, operate LPAC for ten minutes while discharging to atmosphere. At end of ten minutes of operation, stop LPAC by pressing **STOP/RESET** pushbutton switch (7, Figure 2-1).

g) Close air receiver vent valve or reconnect LPAC final air discharge to allow operation against rated pressure.

h) Start LPAC using procedures shown in Chapter 2, Table 2-3 (Automatic Mode).

i) Operate LPAC for one hour. Observe that all pressures are normal and that controls function properly. At end of one-hour operating period stop the LPAC by setting **MAN/AUTO** selector switch (4, Figure 2-1) to **MAN** then pressing **STOP/RESET** pushbutton switch (7, Figure 2-1).

j) Operate LPAC in the Manual Mode for 15 minutes (Refer to Chapter 2, Table 2-4 for Manual Mode Operating Procedures).

k) Operate LPAC in Battle Override Mode for five minutes (refer to Chapter 2, Table 2-5 for Battle Override Operating Procedures).

l) Unit may be placed into normal service if the following conditions are met:

1) LPAC performed satisfactorily.
2) Drive motor has not overheated.
3) All water and air leaks have been corrected.
4) Shutdowns are functioning properly.

8-9.4 Installation Standards Summary Sheet. Record results of the test on the Installation Standards Summary Sheet (refer to Figure 8-1). The Installation Standards Summary Sheet provides space for recording results acquired in phase 2 and phase 3 of the installation checkout. Each space is provided with a paragraph number, which indicates the instruction for accomplishment and the normal expected standard.

SINGLE SCREW AIR COMPRESSOR
STAR 200

CLASS

CAPACITY 200 SCFM AT 125 PSI

BRAKE HORSEPOWER AT PSI DISCHARGE

MANUFACTURED BY
RIX INDUSTRIES

SERIAL NO. CONTRACT NO.

NSN

ITEM

INSP U.S. PROPERTY MFG DATE

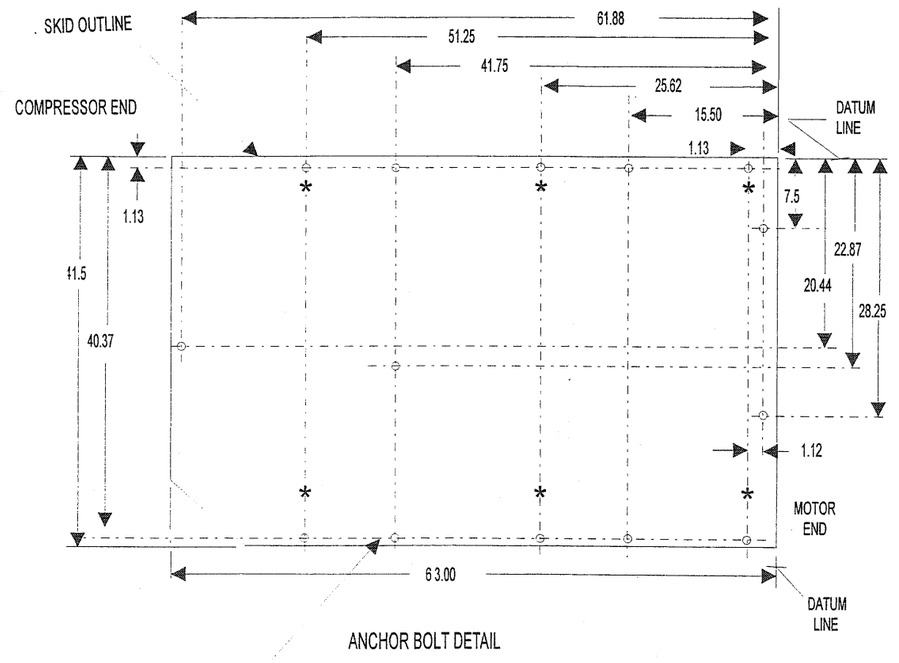
UNIT NAMEPLATE

NOTES :

1. CENTER OF GRAVITY:
2. POWER REQUIREMENTS :
   68.5 AMPS, 3 - PHASE, 440 VAC, 60 Hz.
3. SEE TECHNICAL MANUAL FOR SPECIAL CLEANING REQUIREMENTS, OPERATING INSTRUCTIONS AND CONDITIONS OF SERVICE.
4. SEAWATER REQUIREMENTS :
   40 GPM @ 20 - 175 PSIG.
5. POTABLE WATER REQUIREMENTS :
   40 GPM @ 20 - 60 PSIG.
6. LOCATIONS FOR SIX TYPE 6E900 RESILIENT MOUNTS (IF USED) : *

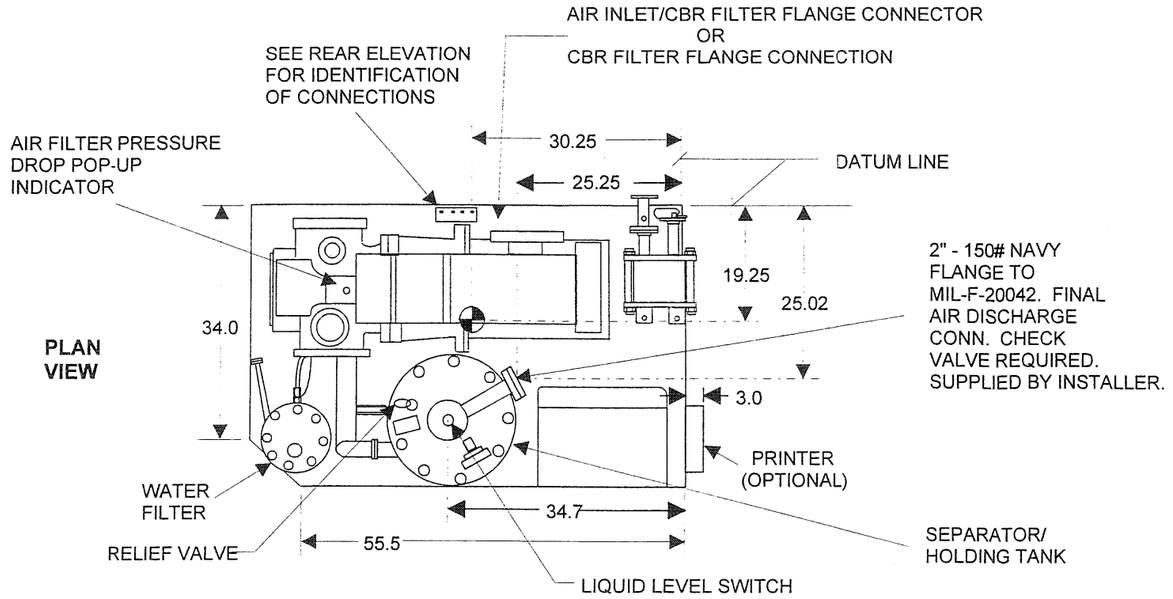
WEIGHTS IN POUNDS

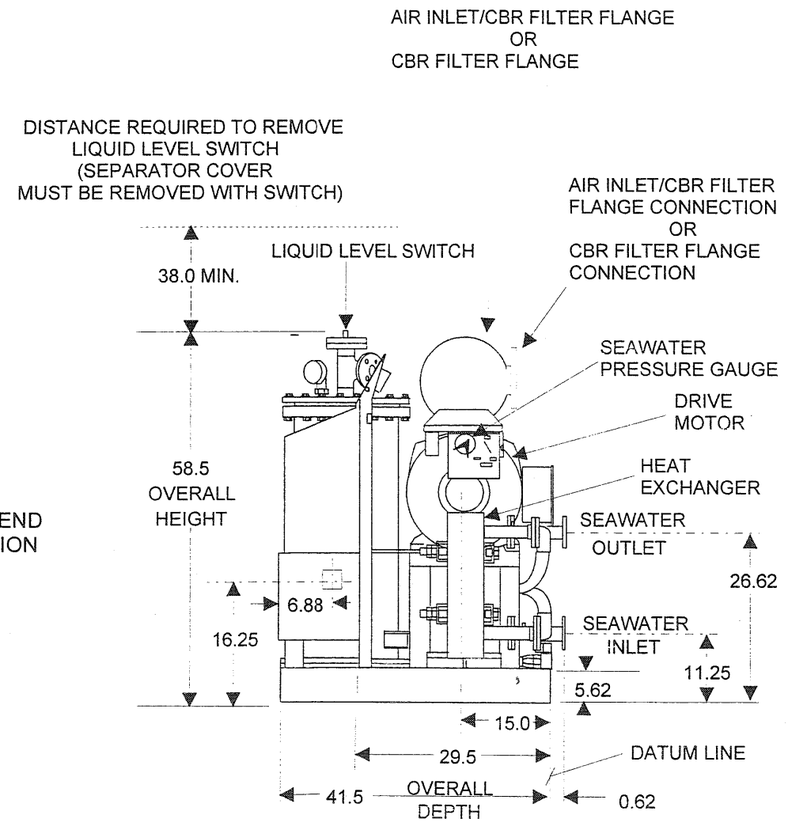
COMPRESSOR & ACCESSORIES	2400
MOTOR (HEAVIEST MAINTENANCE PIECE)	612
WATER.	200
TOTAL NET WEIGHT	3212

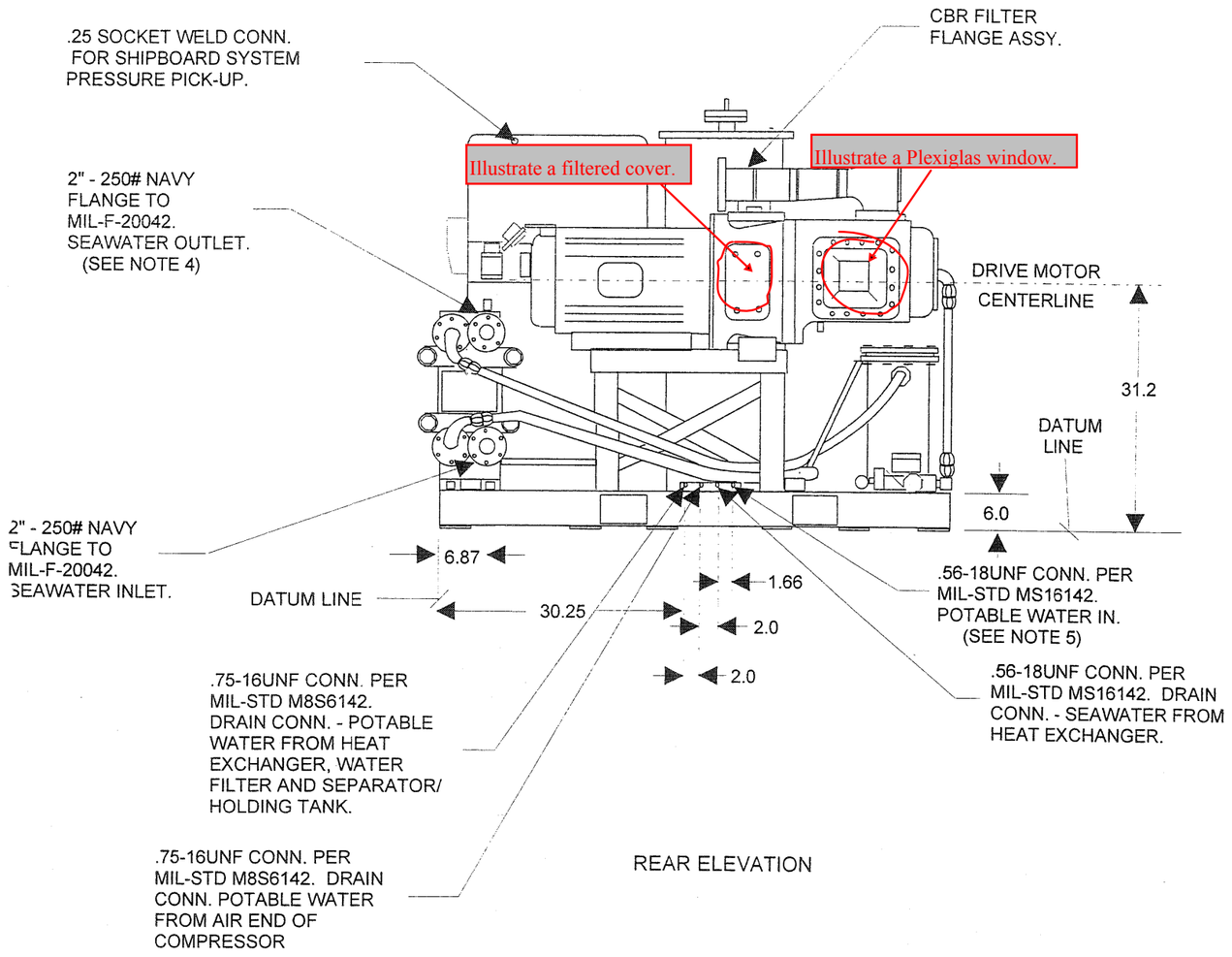


ANCHOR BOLT DETAIL

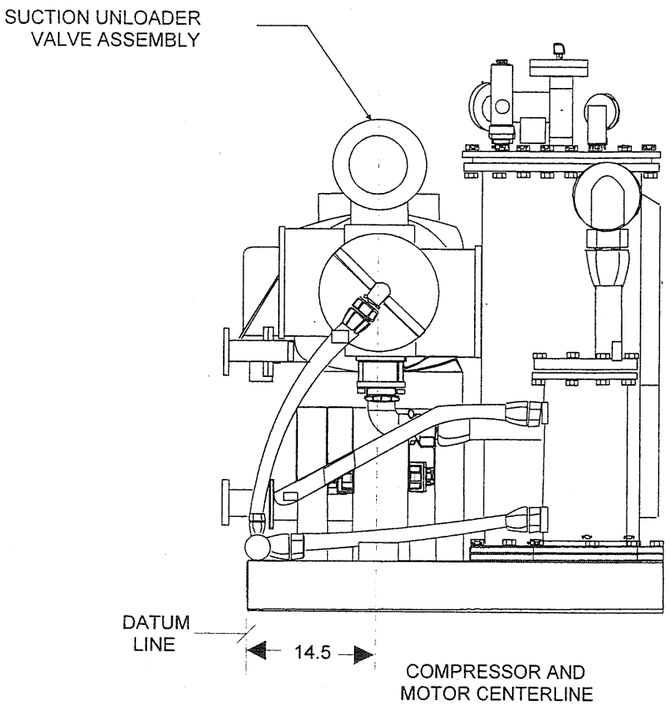
1.062 DIA. - 14 HOLES
FOR 1.0 FOUNDATION BOLTS
(BOLTS SUPPLIED BY INSTALLER)
SKID FRAME THICKNESS AT
BOLTS IS 5.62


AIR INLET/CBR FILTER FLANGE CONNECTOR
OR
CBR FILTER FLANGE CONNECTION
SEE REAR ELEVATION FOR IDENTIFICATION OF CONNECTIONS
AIR FILTER PRESSURE DROP POP-UP INDICATOR
30.25
25.25
DATUM LINE
19.25
25.02
34.0
PLAN VIEW
2" - 150# NAVY FLANGE TO MIL-F-20042. FINAL AIR DISCHARGE CONN. CHECK VALVE REQUIRED. SUPPLIED BY INSTALLER.
3.0
PRINTER (OPTIONAL)
WATER FILTER
34.7
RELIEF VALVE
55.5
SEPARATOR/ HOLDING TANK
LIQUID LEVEL SWITCH
64.0
OVERALL LENGTH
AIR FILTER PRESSURE DROP POP-UP INDICATOR
RELIEF VALVE
FINAL AIR DISCHARGE CONN.
GAUGE PANEL
Illustrate a Plexiglas window.
OPERATOR PANEL
FRONT ELEVATION
CONTROLLER (NOTE 1)
50.44
NAMEPLATE
PRINTER (OPTIONAL)
LIQUID LEVEL SIGHT GLASS
29.0
ELECTRICAL ENCLOSURE
MAKE-UP AND DRAIN VALVE MANAFOLD BLK.
WATER FILTER
2 OPENINGS IN SKID FOR LIFTING WITH FORKLIFT
6.0
6.0
17.5
42.0
63.0
DATUM LINES

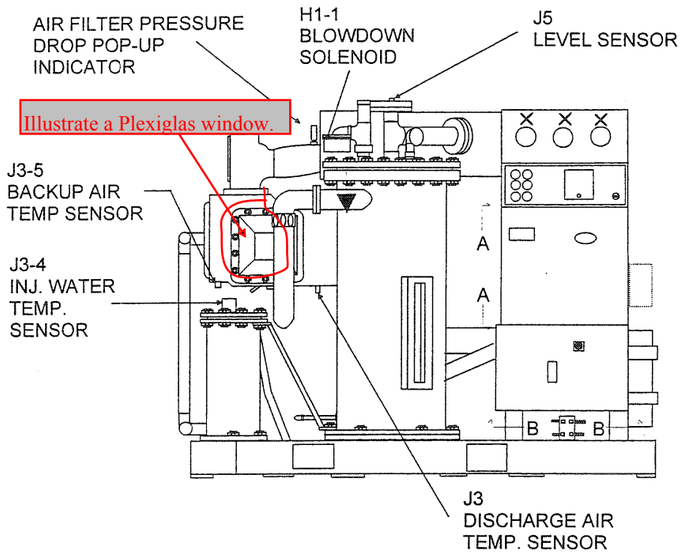

AIR INLET/CBR FILTER FLANGE
OR
CBR FILTER FLANGE
DISTANCE REQUIRED TO REMOVE LIQUID LEVEL SWITCH (SEPARATOR COVER MUST BE REMOVED WITH SWITCH)
LIQUID LEVEL SWITCH
38.0 MIN.
AIR INLET/CBR FILTER FLANGE CONNECTION
OR
CBR FILTER FLANGE CONNECTION
SEAWATER PRESSURE GAUGE
DRIVE MOTOR
HEAT EXCHANGER
58.5
OVERALL HEIGHT
SEAWATER OUTLET
26.62
6.88
16.25
SEAWATER INLET
11.25
5.62
MOTOR END ELEVATION
15.0
29.5
DATUM LINE
41.5
OVERALL DEPTH
0.62



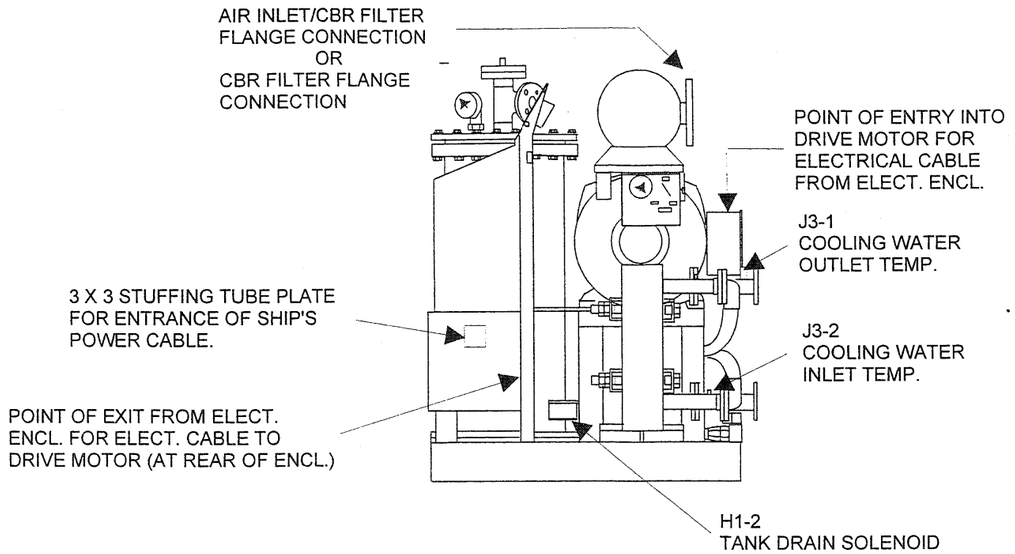
REAR ELEVATION



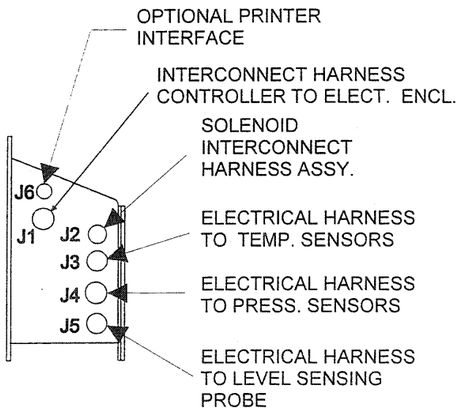
COMPRESSOR AIR END ELEVATION



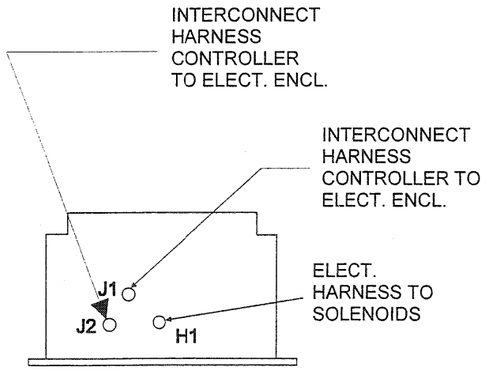
FRONT ELEVATION



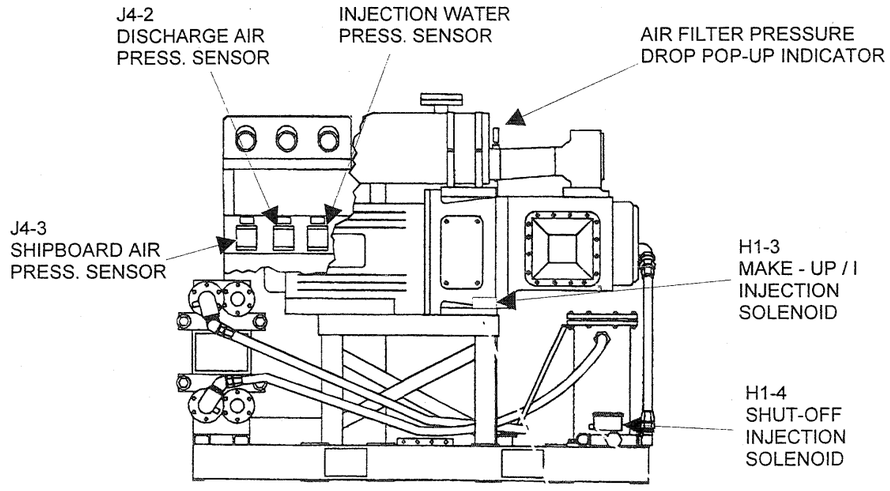
MOTOR END ELEVATION



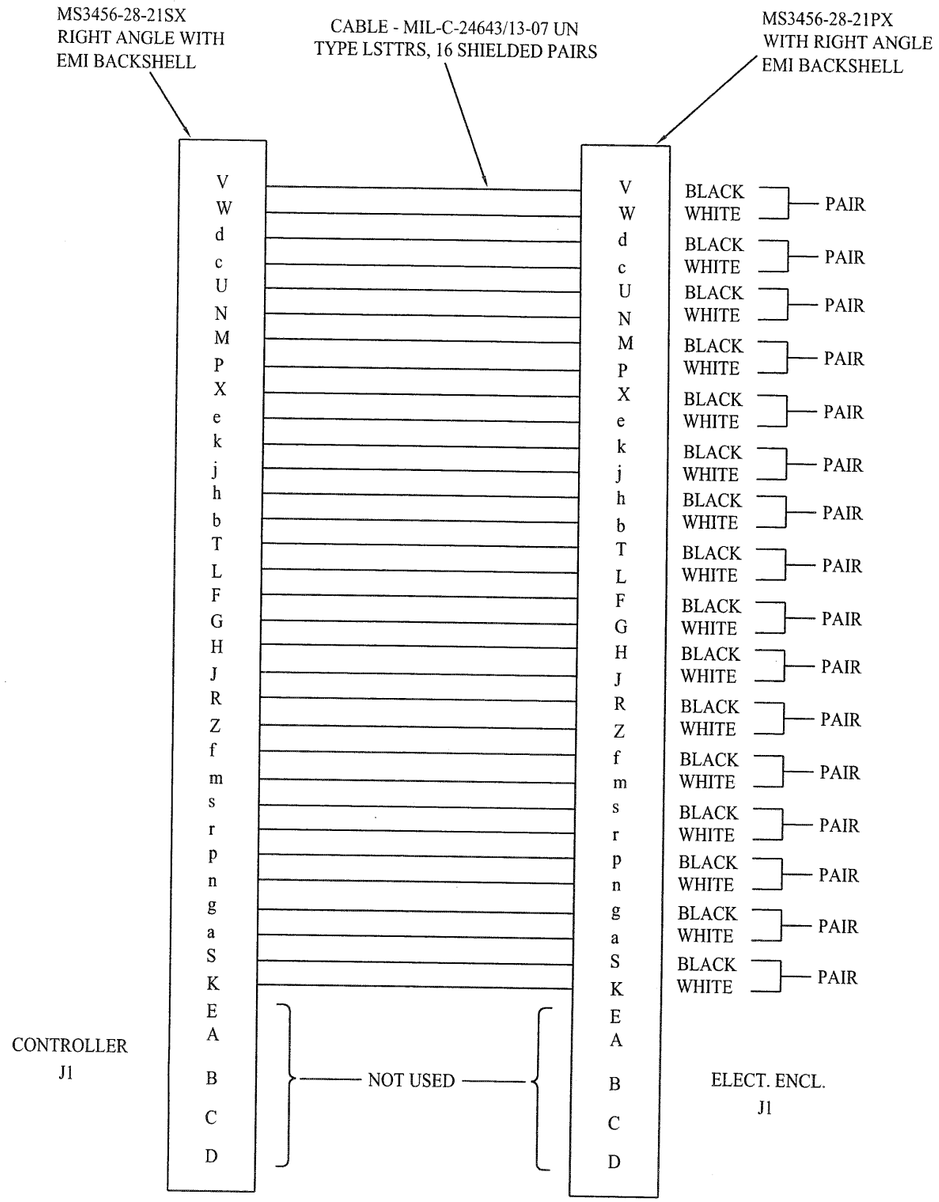
VIEW A - A



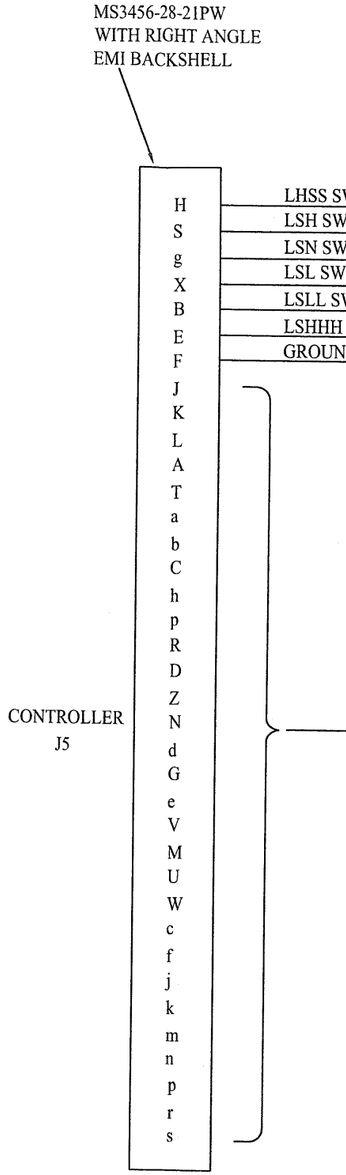
VIEW B - B



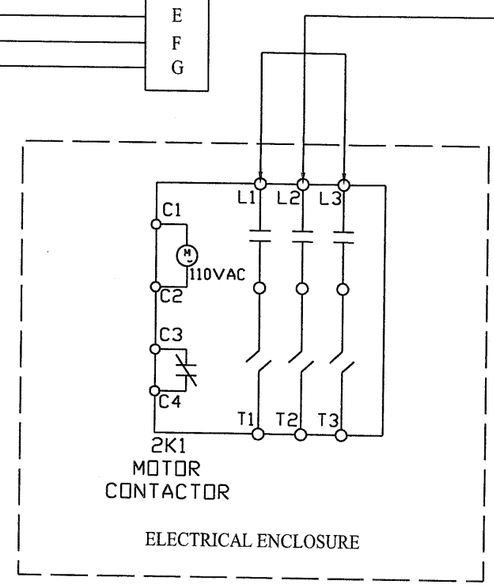
REAR ELEVATION



INTERCONNECT HARNESS J1
(ELECT. ENCL. TO CONTROLLER)
(SUPPLIED WITH LPAC)



ELECTRICAL HARNESS J5
(CONTROLLER TO SEPARATOR/
HOLDING TANK LEVEL SENSOR)
(SUPPLIED WITH LPAC)



MAIN WIRING
(ELECT. ENCL. TO
SHIPS POWER SOURCE)
(SUPPLIED BY INSTALLER)

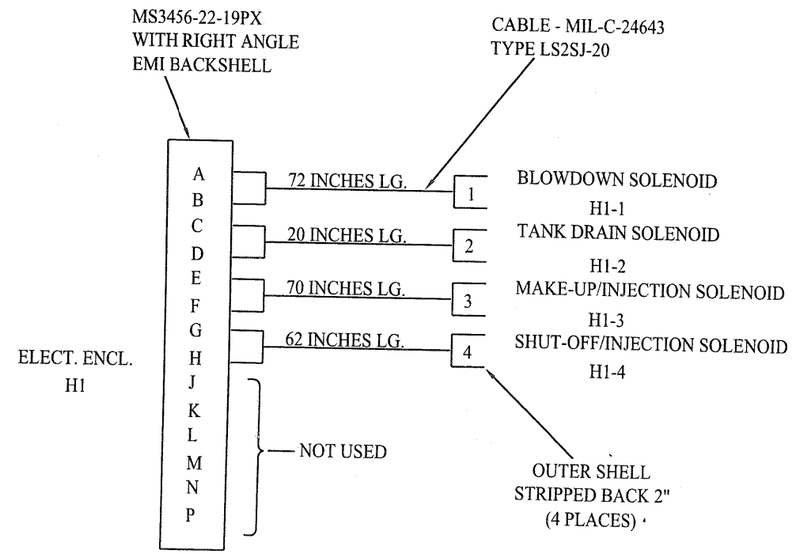
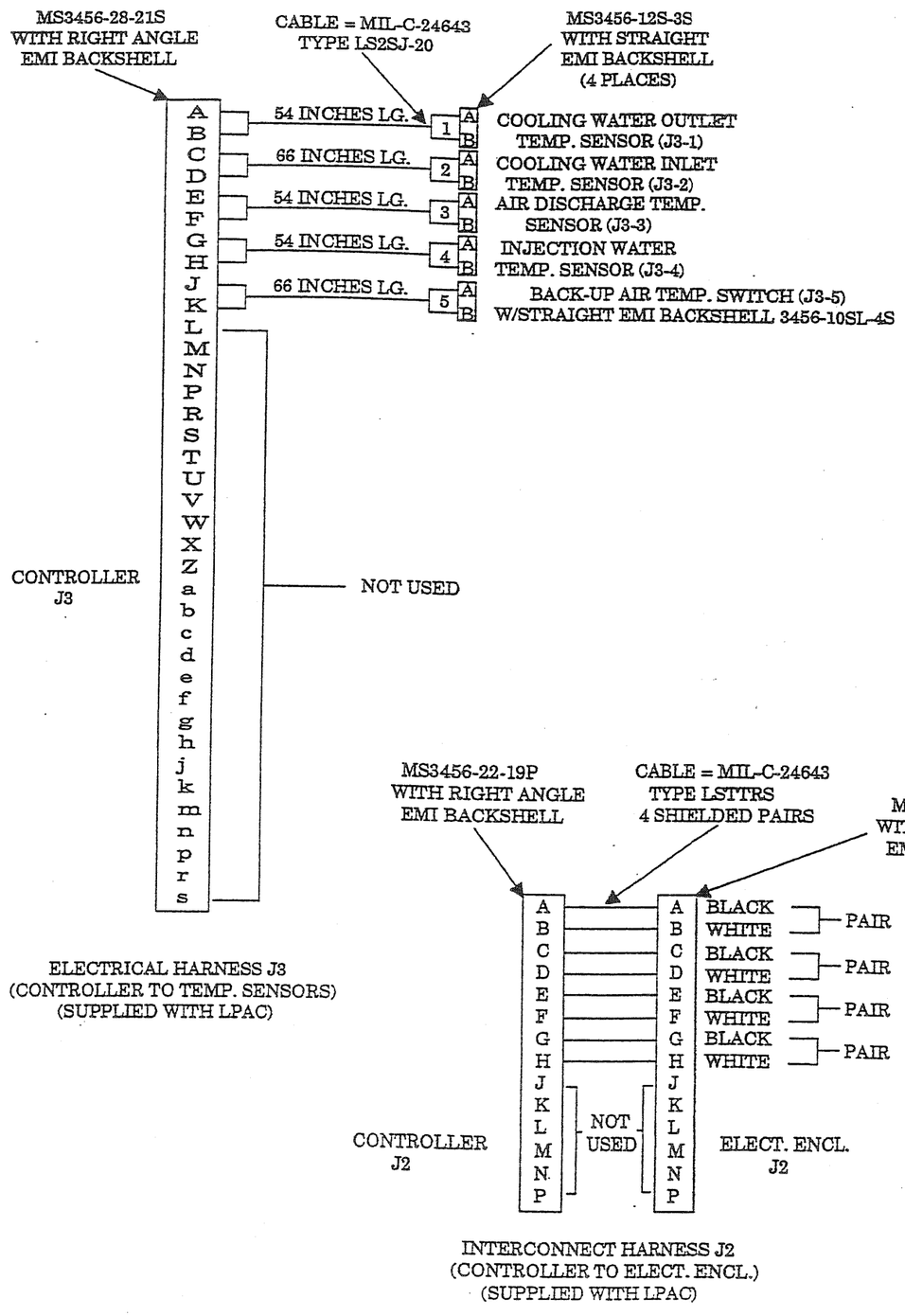
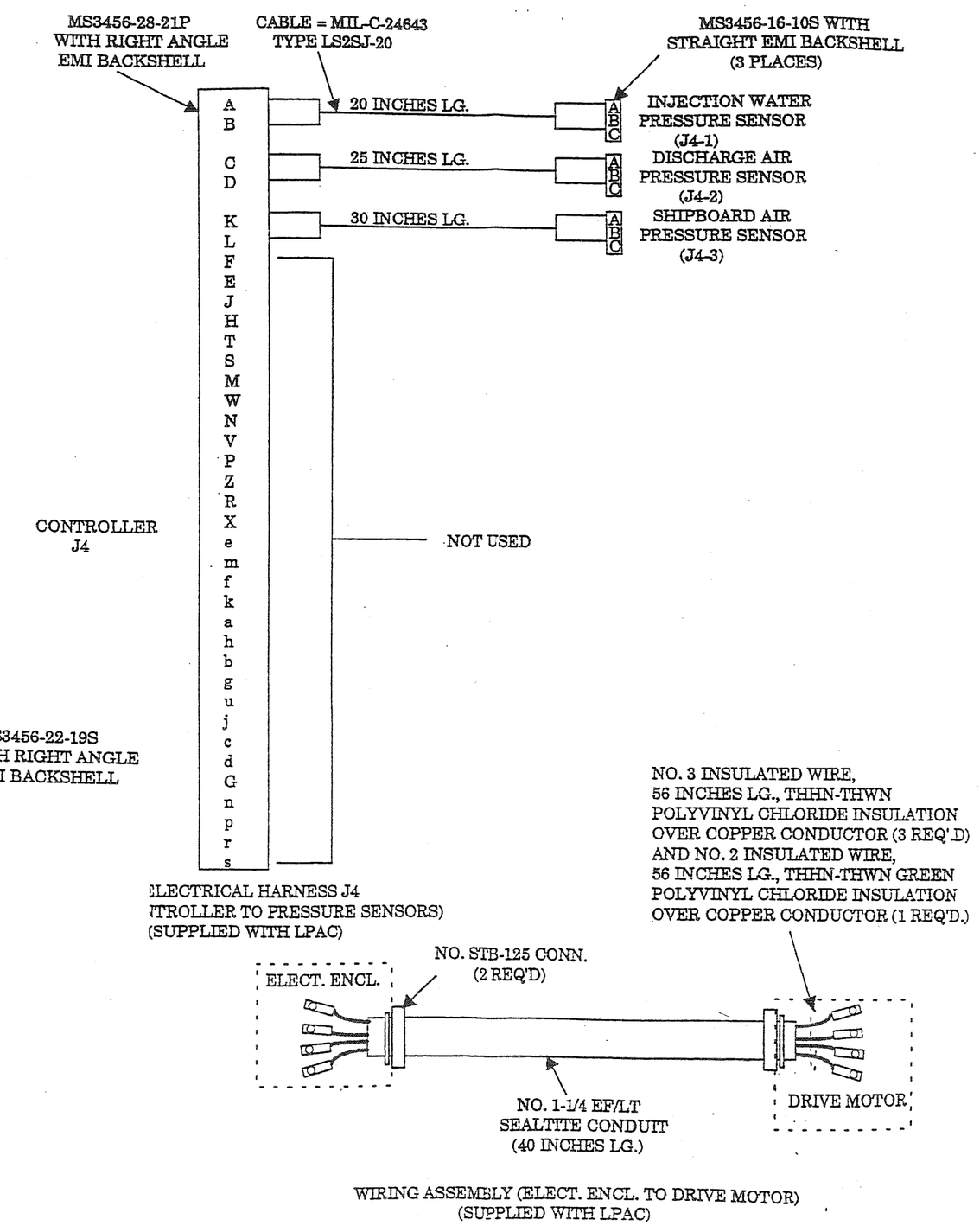
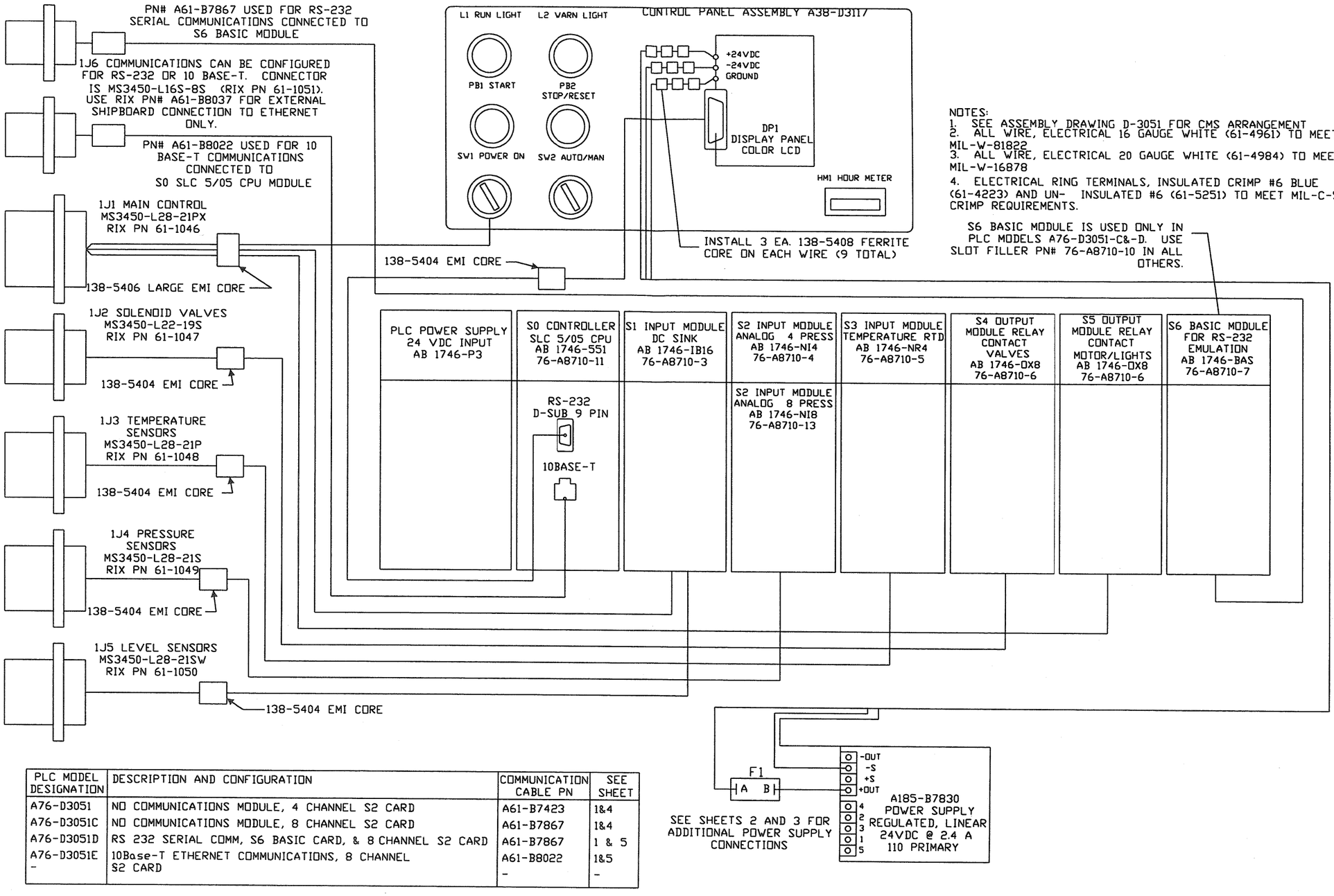


Figure FO-2 General Wiring Sheet (2 of 7)
FP-9/(FP-10 Blank)

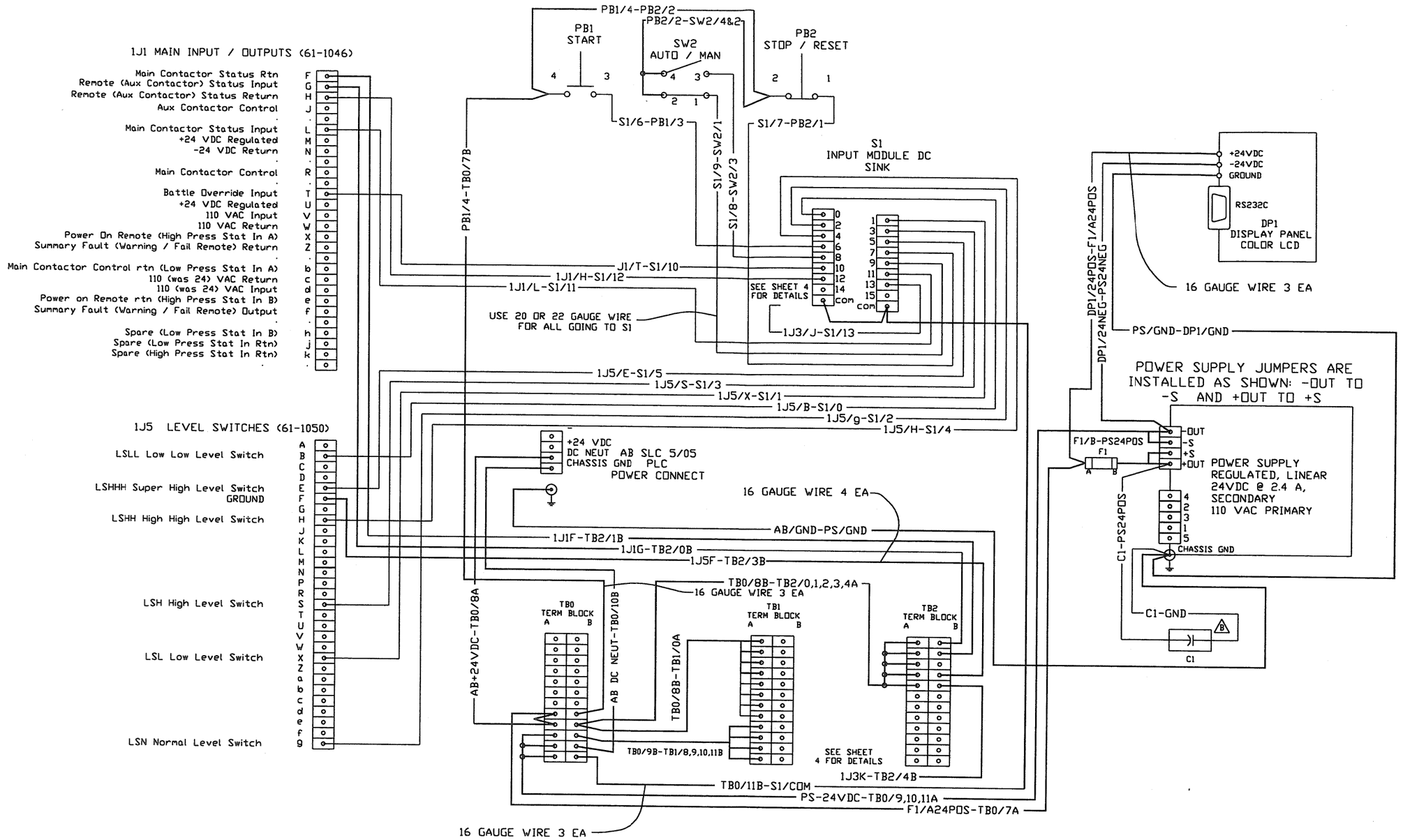

MS3456-28-21S
WITH RIGHT ANGLE
EMI BACKSHELL
CABLE = MIL-C-24643
TYPE LS2SJ-20
MS3456-12S-3S
WITH STRAIGHT
EMI BACKSHELL
(4 PLACES)
54 INCHES LG.
66 INCHES LG.
54 INCHES LG.
54 INCHES LG.
66 INCHES LG.
COOLING WATER OUTLET TEMP. SENSOR (J3-1)
COOLING WATER INLET TEMP. SENSOR (J3-2)
AIR DISCHARGE TEMP. SENSOR (J3-3)
INJECTION WATER TEMP. SENSOR (J3-4)
BACK-UP AIR TEMP. SWITCH (J3-5)
W/STRAIGHT EMI BACKSHELL 3456-10SL-4S
CONTROLLER
J3
NOT USED
ELECTRICAL HARNESS J3
(CONTROLLER TO TEMP. SENSORS)
(SUPPLIED WITH LPAC)
MS3456-22-19P
WITH RIGHT ANGLE
EMI BACKSHELL
CABLE = MIL-C-24643
TYPE LSTTRS
4 SHIELDED PAIRS
MS3456-22-19S
WITH RIGHT ANGLE
EMI BACKSHELL
BLACK
WHITE
PAIR
CONTROLLER
J2
NOT USED
ELECT. ENCL.
J2
INTERCONNECT HARNESS J2
(CONTROLLER TO ELECT. ENCL.)
(SUPPLIED WITH LPAC)


MS3456-28-21P
WITH RIGHT ANGLE
EMI BACKSHELL
CABLE = MIL-C-24643
TYPE LS2SJ-20
MS3456-16-10S WITH
STRAIGHT EMI BACKSHELL
(3 PLACES)
20 INCHES LG.
25 INCHES LG.
30 INCHES LG.
INJECTION WATER PRESSURE SENSOR (J4-1)
DISCHARGE AIR PRESSURE SENSOR (J4-2)
SHIPBOARD AIR PRESSURE SENSOR (J4-3)
CONTROLLER
J4
NOT USED
ELECTRICAL HARNESS J4
NTROLLER TO PRESSURE SENSORS)
(SUPPLIED WITH LPAC)
NO. 3 INSULATED WIRE,
56 INCHES LG., THHN-THWN
POLYVINYL CHLORIDE INSULATION
OVER COPPER CONDUCTOR (3 REQ'D)
AND NO. 2 INSULATED WIRE,
56 INCHES LG., THHN-THWN GREEN
POLYVINYL CHLORIDE INSULATION
OVER COPPER CONDUCTOR (1 REQ'D.)
ELECT. ENCL.
NO. STB-125 CONN.
(2 REQ'D)
NO. 1-1/4 EF/LT
SEALTITE CONDUIT
(40 INCHES LG.)
DRIVE MOTOR
WIRING ASSEMBLY (ELECT. ENCL. TO DRIVE MOTOR)
(SUPPLIED WITH LPAC)



PLC MODEL DESIGNATION	DESCRIPTION AND CONFIGURATION	COMMUNICATION CABLE PN	SEE SHEET
A76-D3051	NO COMMUNICATIONS MODULE, 4 CHANNEL S2 CARD	A61-B7423	1&4
A76-D3051C	NO COMMUNICATIONS MODULE, 8 CHANNEL S2 CARD	A61-B7867	1&4
A76-D3051D	RS 232 SERIAL COMM, S6 BASIC CARD, & 8 CHANNEL S2 CARD	A61-B7867	1 & 5
A76-D3051E	10Base-T ETHERNET COMMUNICATIONS, 8 CHANNEL S2 CARD	A61-B8022	1&5
-		-	-

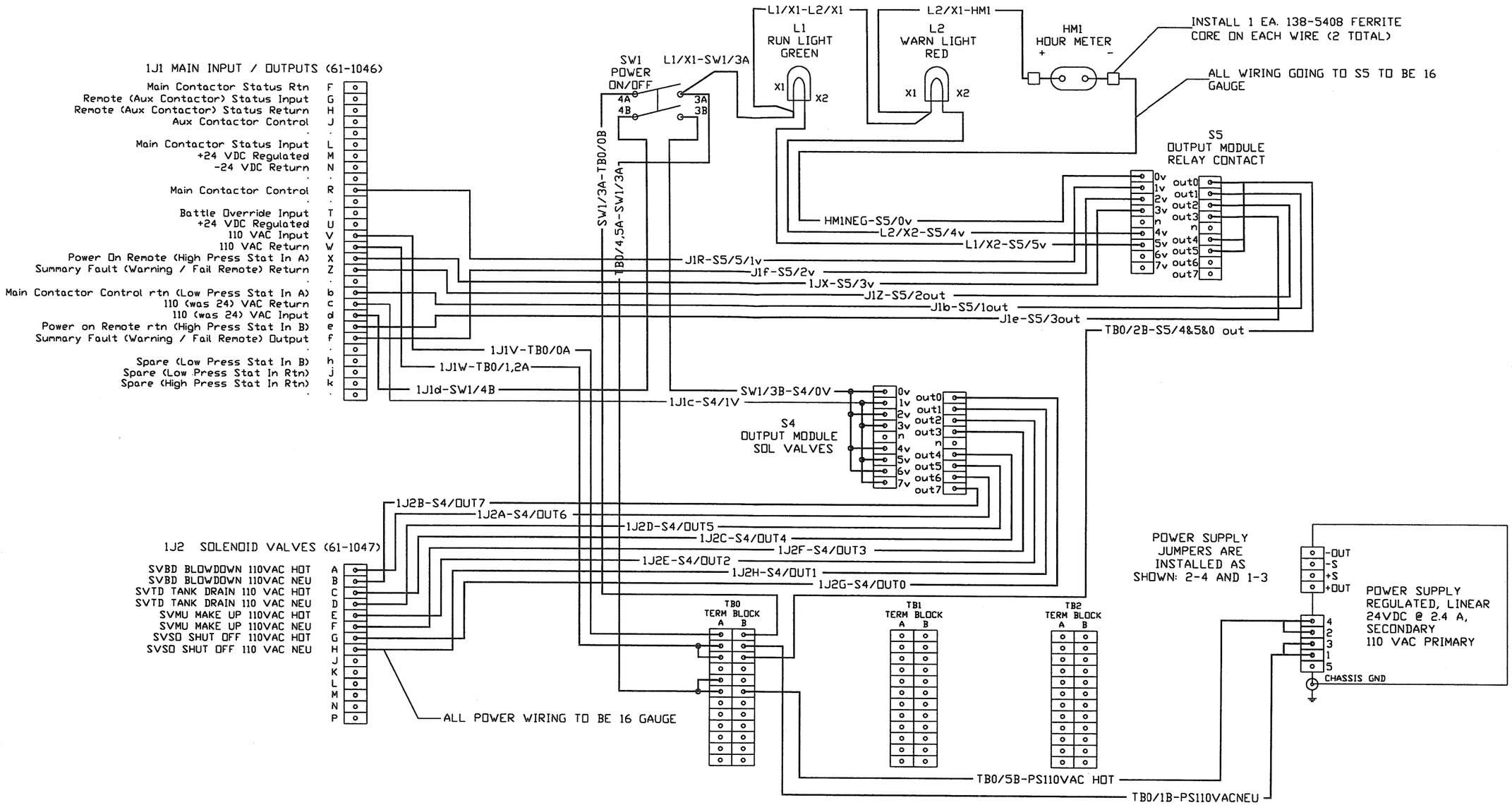
Figure FO-2 General Wiring Sheet (4 of 7)
FP-13/(FP-14 Blank)



NOTES:

1. SEE ASSEMBLY DRAWING D-3051 FOR CMS ARRANGMENT
2. ALL WIRE, ELECTRICAL 16 GAUGE WHITE (61-4961) TO MEET MIL-W-81822
3. ALL WIRE, ELECTRICAL 20 GAUGE WHITE (61-4984) TO MEET MIL-W-16878
4. ELECTRICAL RING TERMINALS, INSULATED CRIMP #6 BLUE (61-4223) AND UN- INSULATED #6 (61-5,251) TO MEET MIL-C-5015 CRIMP REQUIRMENTS.

Figure FO-2 General Wiring Sheet (5 of 7)
FP-15/(FP-16 Blank)



2. ALL WIRE, ELECTRICAL 16 GAUGE WHITE (61-4961) TO MEET MIL-W-81822
3. ALL WIRE, ELECTRICAL 20 GAUGE WHITE (61-4984) TO MEET MIL-W-16878
4. ELECTRICAL RING TERMINALS, INSULATED CRIMP #6 BLUE (61-4223) AND UN- INSULATED #6 (61-5,251) TO MEET MIL-C-5015 CRIMP REQUIRMENTS.

Figure FO-2 General Wiring Sheet (6 of 7)
FP-17/(FP-18 Blank)

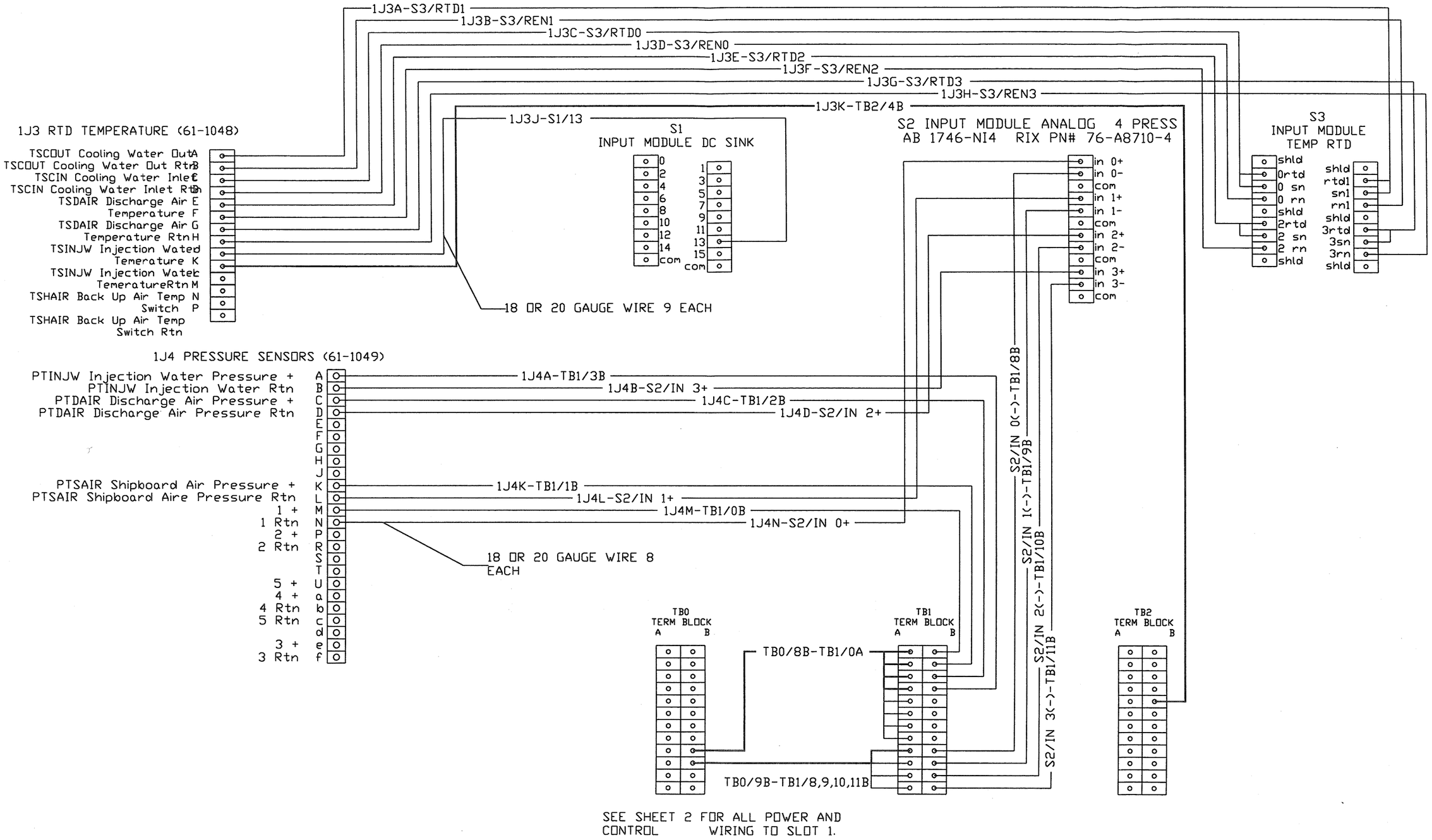
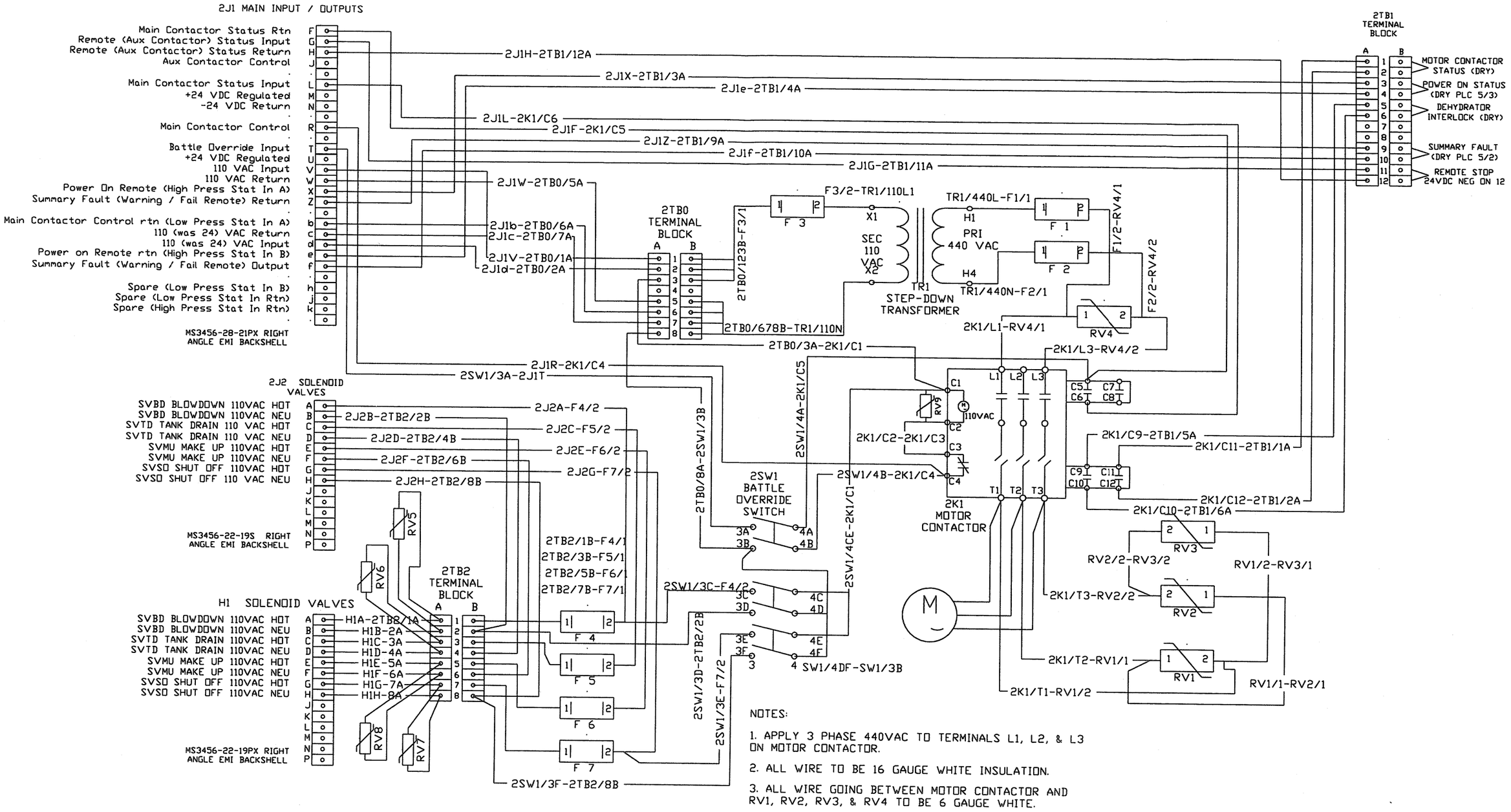


Figure FO-2 General Wiring Sheet (7 of 7)
FP-19/(FP-20 Blank)



NOTES:

1. APPLY 3 PHASE 440VAC TO TERMINALS L1, L2, & L3 ON MOTOR CONTACTOR.
2. ALL WIRE TO BE 16 GAUGE WHITE INSULATION.
3. ALL WIRE GOING BETWEEN MOTOR CONTACTOR AND RV1, RV2, RV3, & RV4 TO BE 6 GAUGE WHITE.

Figure FO-3 HVE Wiring Sheet (1 of 1)
FP-21/(FP-22 Blank)

INDEX

D

E

Subject — Paragraph, Figure, Table, Number

O

P

R

Subject — Paragraph, Figure, Table, Number

S

Subject — Paragraph, Figure, Table, Number

W